Instruments

[E MAGAZINE of MEASUREMENT and CONTROL

Vol. 21 FEBRUARY 1948 No. 2

luding the JOURNAL of the Instrument Society of America

Announcement

The WESTON Electrical Instrument Corporation of Newark, N. J. has purchased the assets of the C. J. Tagliabue Corporation, Inc., of Brooklyn, N. Y., and is now operating the Tagliabue business at its present address in Brooklyn under the name of C. J. TAGLIABUE Corporation (N. J.) — a subsidiary of WESTON.

The field sales and service organization of the former Company will be maintained, and inquiries regarding apparatus or service should continue to be addressed to them in their respective localities, or to the

C. J. TAGLIABUE Corporation (N. J.)
Park and Nostrand Avenues
Brooklyn, N. Y.

At some later date, the Tagliabue manufacturing facilities will be moved to Newark and integrated with the WESTON organization. This transfer will be made in a manner to minimize any interference with the normal conduct of business.

This acquisition greatly expands the scope of WESTON'S service to instrument users, by including a line of Recorders, Controllers, Thermometers, Moisture Meters, and other products. Tagliabue instruments have long been in high repute for their exceptional standard of quality. Henceforth, this esteem will be further enhanced by the prestige of WESTON'S acknowledged leadership in instrument design and manufacture.

WESTON Electrical Instrument Corporation
591 Frelinghuysen Avenue, Newark 5, N. J.

What's Happening in Tower 5?

A logical question. The answer should be at the finger tip of the man responsible.

You can put your finger on processing temperatures anywhere as quickly as you touch a button. The Brown *ElectroniK* Precision Indicator *brings temperatures to you* with a speed and accuracy unparalleled by any other form of instrumentation today.

It is available with as many as 48 push-button switches for picking out temperatures anywhere in your plant. A new form, now available, even provides for cutting in on recorder circuits to check all critical temperatures from one central location.

The 28-inch rotating scale makes split-degree readings easy, yet with the *ElectroniK* Potentiometer, operation is so fast and accurate that a series of temperatures can be read as fast as they can be logged.

Far-flung as your processes may be, the Brown *ElectroniK* Precision Indicator will help "pull your plant together" with efficient, centralized temperature readings.

Further information will be gladly forwarded to you.

THE BROWN INSTRUMENT CO., 4482 WAYNE AVE., PHILADELPHIA 44, PA.
DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR CO.
Offices in principal cities of the United States, Canada and throughout the world

BROWN *Advanced Instrumentation* **FOR BETTER PROCESSING**
Product of MINNEAPOLIS **Honeywell**

Quality AT A GLANCE

...in a FINE WATCH

...in a

FALSTROM PANEL

Modern Console Type Testing Control Center for Precision Instruments

A FINE panelboard does much more for the instruments on it than support them properly. Just as the scintillating case of a fine watch points to the worth of the precision movement within it—so the design, smooth lines and custom features of a Falstrom Panel indicate the outstanding superiority of the entire control assembly... *quality at a glance!* Write for illustrated bulletins S125 and S126.

STRUCTURES FOR EVERY CONTROL REQUIREMENT

New Knocked-Down Cubicles

Control Panel with Monitor's Desk

Heavy Duty Public Utility Cubicle

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Instruments THE MAGAZINE OF *Measurement and Control*

Vol. 21 **February 1948** No. 2

TWENTIETH ANNIVERSARY FEATURE

A "Historical Museum *on* Paper" *of* American Instruments *in* Science *and* Industry

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DISTRICT OFFICES AND MANAGERS

MEMBER ABC Audit Bureau of Circulations

James Condon, 36 Myrtle St., *Boston* 14, Mass. (Lafayette 3-0829). Stuart Rogers, Room 928, 17 East 42nd St., *New York* 17, N. Y. (Murray Hill 2-0821). Harold W. Haskett, 742 Elberon Ave., *Cincinnati* 5, Ohio (Grandview 4323). Room 615, 360 N. Michigan Ave., *Chicago* 1, Ill. (Andover 4299). James R. Wright, 411 North Tenth St., *St. Louis* 1, Mo. (Chestnut 1965). M. D. Pugh, 2721 N. Marengo Ave. *Altadena*, Calif. (Sycamore 7-2894). C. F. Goldcamp, 1117 Wolfendale St., *Pittsburgh* 12, Pa. (Fairfax 0161).

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Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

IN compliance with the Publisher's decision, the Twentieth Anniversary historical feature is not concluded this month. Extracts from the January foreword are repeated:

THIS Special Issue is not a history but a "historical museum on paper" of American instruments in science and industry. Containing, as it does, a wealth of historical data, it risks being referred to as "a history." We fervently hope that no one will so refer to it; and we particularly beg reviewers not to do so in print. Just as there is an enormous difference between a mass of data (the raw material of science) and a science, so there is a difference between a mass of documents (the raw material of history) and a smooth piece of writing that deserves to be called a history.

SOME day a history of American instruments will be written. It should be a fascinating best-seller; it might be a dull flop. As a contribution to the proper preparation of such a history, this editorial introduction will recite facts and circumstances. Another purpose is to make readers enjoy this issue with keener zest—human interest, even drama, pervades the following pages.

But before we go into these details we express deep appreciation of the tremendous amount of work done by the hundreds of contributors: Tens of thousands of man-hours in hundreds of offices, laboratories, and plants have gone into making possible this Special Issue!

THE PLAN.—Burns was right when he wrote about "the best-laid plans of mice and men . . ." No finer plan could have been conceived than the one adopted last summer:

(1) The Twentieth Anniversary Issue to be a historical issue, chiefly of "FIRSTS." (In view of the modesty of many old-timers in the industry, the term "outstanding development" was used in addition to the word "first.")

(2) The issue to be made up entirely of contributions mailed to *Instruments;* no historical delving or writing by the editor, because such work would take years instead of months.

THE INVITATIONS.—Various letters and advertisements were prepared last summer, in which the plan was outlined and the simple "rules" explained. It was stipulated that EACH description was to mention WHY the development was outstanding.

"EVERYBODY INVITED.—The mailing list included all instrument manufacturers; also instrument designers and makers in governmental and private institutions. Thousands of persons not on this list received notification through the magazine *The Instrument Maker.*

"HUMAN NATURE" FOILS PERFECT PLAN.—Most early contributions consisted of catalogs. The letter usually ran:

All of our latest models are of historical importance. However, I'll forgive you if you don't print pictures and descriptions of all of them. Look over our line: pick out items and send me a list: I'll then send you cuts or photographs.

P. S. Submit your write-ups to me before you print them.

In mid-October a "personalized form letter" was sent to every name on the master list. Extracts:

Some of you have sent us a mass of booklets and asked us to pick out your historic achievements. Sorry, no can do!

You are the one to send us the pictures and to write the descriptions or narratives.

Each contribution should be SIGNED. Each description should mention WHY the development was outstanding.

Some of you, who sent us photos and descriptions of new models just brought out, may believe that these new products are as "outstanding" as, say, the first thermometer made in America; but . . . please don't force us to assume the onerous role of censor.

The total number of contributions could not even be counted because most of them were not usable, being the thousands of items in catalogs. This raw material would fill an eight-foot bookshelf, but there are two deplorable absences:

(1) The absence of truly historical material from some old-established companies, whose officials chose to send us only descriptions of recent outstanding developments;

(2) The absence of ANY contributions from certain companies which advertise in *Instruments* and otherwise cultivate the good-will of *Instruments* readers; the only explanation is that their officials "leaned backward" with extreme modesty. This, too, is an inevitable manifestation of human nature, as is shown for example when prizes and medals are awarded: on almost every such occasion, some winners refuse to attend the ceremonies and even refuse to accept the honors due them.

Your editor, and The Instruments Publishing Company, Inc., hereby disclaim responsibility for assertions of priority and this disclaimer is supported by the original manuscripts. Careful as we were to preserve wordings when re-writing lengthy descriptions, we were extra-careful in such cases of "firsts": WE DID NOT EDIT SUCH ASSERTIONS AT ALL. Where assertions are made flatly, they are the authors' own assertions.

Exaggerations made as flat assertions were not edited.

Similarly, when the description of an original model was accompanied by a photograph (of what looks like a modern model but is) PLAINLY MARKED WITH THE YEAR OF THE ORIGINAL, we unquestioningly used this photograph.

Seldom does *Instruments* comply with requests that its "write-ups" be "submitted for approval" before being printed. This time, such requests did not even draw replies.

Many writers included in the description of one specific development numerous explanations of its importance to the design of later developments which were not dated and for which no SPECIFIC descriptions were written. Inexcusable as this was, we studied all these meandering stories and extracted all we could for insertion under later dates. This took about a hundred hours.

Most of the raw material as received was—well, terribly raw. To correspond individually with all these writers, returning their contributions and offering criticisms and suggestions as we do with authors of technical articles, would have meant more than two hundred hours of dictation, two thousand hours of supplemental editorial work, etc. Special letters asking for essential data such as dates, etc., were sent by an assistant who enclosed copies of the rules. These simple inquiries should have drawn 100% replies; they did not! Many writers must have re-read the rules and said to themselves, "Oh, well, I've made a flop of my stories and it's too late to try to fix them up!" Even then, we did not discard these unusable contributions: we made them usable whenever possible! How? That, dear friend, is a secret—which you could have learned if you had dropped in between 1 and 4 a.m. on many a wintry night! —MFB

A "Historical Museum *on* Paper" *of* AMERICAN INSTRUMENTS *in* Science *and* Industry

Please read the foregoing editorial explanation.

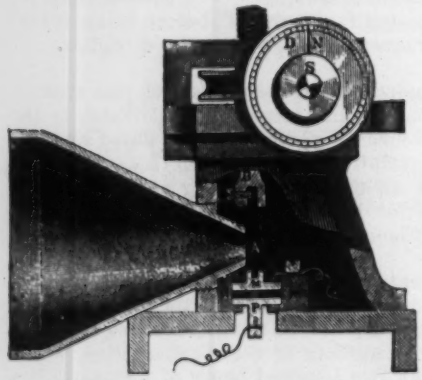
In this first section: Items that would have been included in our January issue if not delayed in the mails. The packages from Mr. Mann and Mr. Cox were both mailed shortly before Christmas. Evidently, temporary postal employees were to blame. Since the delay was not the fault of these two contributors, we accepted and processed their material. Contributions received too late for our January issue because they were *mailed too late* are NOT used in this February issue.—MFB.

1878. Edison's "Tasimeter." "One of the most interesting 'firsts' seems to be the 'Tasimeter' which Mr. Edison built in order to measure the heat of the sun's corona during a total eclipse on July 29, 1878."—H. K. Mann, Instrument Div., Thomas A. Edison, Inc.

[NOTE.—Mr. Mann enclosed a four-page reprint of Edison's report to Professor Henry Draper, Director of the Draper Eclipse Expedition, as published in *Proceedings of the American Association for the Advancement of Science, St. Louis Meeting, August 1878.* Edison reports that he only finished building the instrument two days before leaving for Wyoming, where the eclipse was total; unfortunately, his report deals mostly with the troublesome last-minute adjustments of the Wheatstone bridge, Thompson reflecting galvanometer and other auxiliary devices which prevented Edison from calibrating his apparatus in time for the eclipse. Edison's only references to the operating principle of the "Tasimeter" itself are the following:

"This instrument I have named the tasimeter, from the Greek words τασις, extension and μετρον measure, because primarily the effect is to measure extension of any kind. . . . If the strip of vulcanized rubber was exposed to heat from any source, it expanded, placing pressure upon the carbon button, thus decreasing its resistance and destroying the balance, thus allowing a current to pass through the bridge wire . . . the amount of this current of course being proportional to the expansion of the rubber and to the strength of the battery."

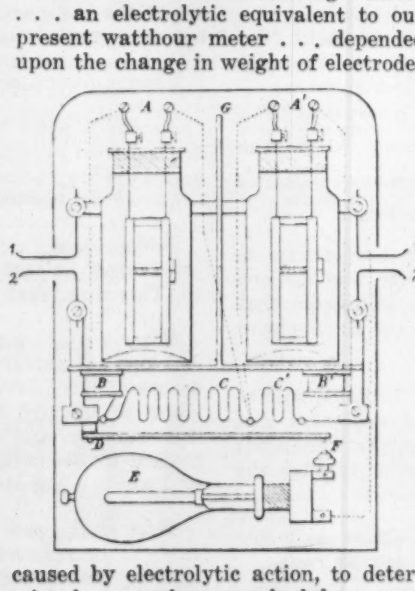
From this and the wood-cut here reproduced, it appears that Edison's Tasimeter" was a form of radiation pyrometer utilizing



the expansion and contraction of a strip of hard rubber *A* at the focus of a cone; and measuring these dimensional changes by what would be called today a carbon-resistance type of strain gage (*R, M, C, P*). The purpose of the adjusting knob-and-scale (*D, N, S*) worm-wheel and vertical-screw arrangement evidently was to adjust the initial pressure upon the carbon button in order to balance the bridge circuit before allowing the radiation from the sun's corona to heat the hard-rubber strip.—M. F. BEHAR, EDITOR]

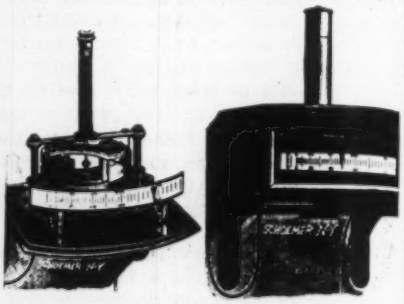
1878. The Sonorous Voltameter. "Thomas A. Edison made the following disclosure in August 1878: 'The sonorous or bubble voltameter consists of an electrolytic cell with two electrodes, one in free contact with a standard decomposable solution and the other completely insulated by vulcanized rubber except two small apertures, one of which gives the solution free access to the insulated electrode, and the other allows the escape of bubbles of hydrogen as they are evolved by electrolysis. With a given current and a given resistance a bubble is obtained each second, which is seen at the moment of rise and which at the same time gives a sound when it reaches the air. The resistanc may be increased so as to give one bubble in one, five, ten or fifty seconds, or in as many hours. I have compared this instrument with the ordinary voltameter, and find it much more accurate . . . .' This appeared in the *Proceedings* of the American Association for the Advancement of Science. The remainder of Edison's disclosure is not important with regard to instrument design. No illustration was printed."—H. K. Mann, Instrument Div., Thomas A. Edison, Inc.

1882. "The Edison electric light meter . . . an electrolytic equivalent to our present watthour meter . . . depended upon the change in weight of electrodes



caused by electrolytic action, to determine how much power had been consumed by the customer. These meters were apparently in rather common usage in the Edison lighting system as early as 1882 . . ."—H. K. Mann, Instrument Div., Thomas A. Edison, Inc.

c. 1899. Voltmeters and ammeters. ". . . the first catalog of the Edison Mfg. Co. which was apparently published about 1899 . . . The probability is that most of these [instruments] were first made by Mr. Edison and that this catalog represents the first offering to the general market following development and reduction to something approaching commercial practice . . . What we commonly know today as electrostatic voltmeters apparently were developed by Mr. Edison working with Dr. Kennelly during the period that Dr. Kennelly worked as Mr. Edison's assistant, of course many years prior to his going to Harvard to teach. . . . a string suspension holding the set of moving plates between a set of stationary plates. Attached to the rotor is a pointer which travels over a horizontal scale. . . . two ranges of voltage: 0-600 and 0-1200. . . .



Kennelly Standard Static Voltmeter.

FOR HIGH TENSION CURRENTS, BOTH CONTINUOUS AND ALTERNATING.

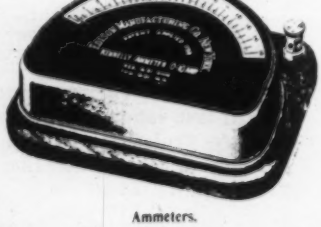
Scale, 0 to 600 Volts, - $40.00. Scale, 0 to 1200 Volts, - $40.00.

This instrument is designed on the well known principle of the electrometer. Among the great advantages possessed by this instrument are the following: It consumes absolutely no current. It is not affected by dynamos. It is easily calibrated and when once installed it never needs recalibration. The divisions in the scale are most open between the working limits of the various systems for which the instruments are designed, viz.: between 400 and 600 volts on the 600 volt instrument, and between 900 and 1,200 volts on the 1,200 volt instrument.

50

THE EDISON

STANDARD AMMETER AND MILLIAMMETER.



Ammeters.

Scale 0 to 5 amperes, divisions $\frac{1}{4}$ ampere.
" 0 to 15 " " $\frac{1}{2}$ "
" 0 to 25 " " 1 "
" 0 to 50 " " 2 "

Milliammeters.

Scale 0 to 100 milliamperes, divisions 1 milliampere.
" 0 to 200 " " 2 "
" 0 to 500 " " 5 "

A few points demonstrating the special features distinguishing these instruments from all others now in use:

1st. They have no iron, steel, or magnetic metal in their moving parts which subsequently will not alter or demagnetize under any reasonable treatment.

2nd. They are not affected by the earth's magnetic field, nor even by the field of dynamos beyond a few feet radius.

3rd. The scales are nearly uniform, and very distinct, being read off with ease to avoid parallax.

4th. The movements of the indicator are practically dead beat.

5th. The instruments are calibrated and standardized at the Edison Laboratory.

6th. They have very low resistance and in fact are so low that even great electro-magnetic power, combined with very little influence of the [illegible] whose current strength they measure. The resistance of the [illegible] pere instrument is 0.3 ohm and its inductance is more [illegible]

7th. They are very compact and portable, the outside dimensions of the instrument being 6¼ in. by 8¾ in. by 2¾ in. high and their weight in a polished case, six pounds.

8th. There are no adjustments, leveling screws or clamps for the [illegible] the instruments are always ready for operation, and can be used in any position.

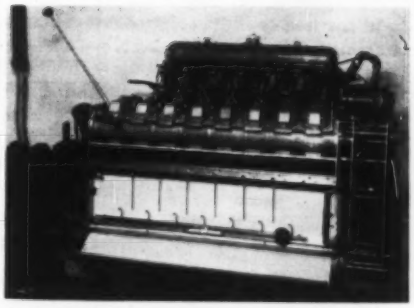
9th. The binding posts are large and strong. They will take the direct penetration of a small wire by clamping.

On page 59, ammeters in four ranges and milliammeters in three ranges . . . mirror-scale instruments . . . The text reads in part: 'Special features distinguishing these instruments from all others now in use. They have no iron, steel or magnetic metal in their moving parts . . . The scales are nearly uniform . . .' We do not necessarily claim that all of these are 'Firsts,' because we are not in a position to produce ironclad

proof of such statements; but, from the information available, it is reasonable to suppose that all of the above-mentioned products were first developed and produced by this Company or by one of its predecessors."—H. K. Mann, Instrument Div., Thomas A. Edison, Inc.

1927. "The first variable-area multiple-stage, direct-reading air-flow indicator. . . . designed for measuring volumetric efficiency of automobile engines and mixture ratio of carburetors. . . . The first variable-area liquid flowmeter with machined-in guides and logarithmic scales. . . . designed for measuring fuel consumption of automobile engines in laboratory tests."—Claude E. Cox, President, Commercial Research Laboratories, Inc.

1928. "The first direct-recording, direct pressure multiple engine indicator



for drawing pressure diagrams on a paper chart from all cylinders of a multiple-cylinder, high-speed automobile engine simultaneously. . . . utilized the 'stroboscopic' or 'sampling valve' principle in which a small slide valve direct-driven by the engine (with variable phase relation thereto) was interposed between the combustion chamber of each cylinder and its recording unit. All cards were drawn in phase on a single chart, the base lines representing crank shaft degrees."—Claude E. Cox, President, Commercial Research Laboratories, Inc.

1928. "The first combination unit of a fuel flowmeter, a filter and an automatic air and vapor trap for testing the fuel consumption of automobile engines."—Claude E. Cox, President, Commercial Research Laboratories, Inc.

1929. "The first electrically-operated 'stroboscopic' or 'sampling valve' unit for use with a recorder unit for the direct recording of pressure diagrams. Also the incorporation therein of a spark plug so that pressure diagrams could be drawn from any or all cylinders of high-speed automobile engines by using the spark plug openings, thus avoiding the necessity of special machining of the cylinder block."—Claude E. Cox, President, Commercial Research Laboratories, Inc.

FOURTH "GALLERY"

From *the* End *of the* First World War *to* Electronics *in* Industry

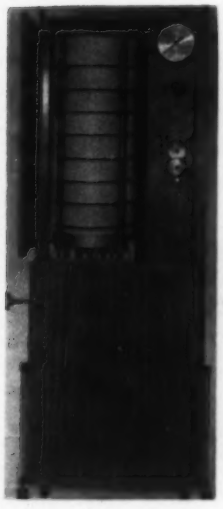
(Concluded)

1930 (*Concluded*)

1930. "Close-control Power Rheostats . . . radically new type, circular, wire-wound, all ceramic and metal units . . . Smoothness of control previously was associated only with special laboratory rheostats not conveniently suited to instrument applications, mounting on panels, etc. Introduced in the 50-watt size, the line increased to ten sizes, 25 to 1000 watts, in a wide range of resistance values . . ."—L. H. Ritzma, Ohmite Mfg. Co.

1930. "Adjustable Port Fuel-air Proportioning Valve. . . . simplified combustion operations on industrial furnaces only one adjustment to make for both air and oil or air and gas, . . . instead of the usual dual adjustments for fuel and air . . . fuel and air valve components of assembly were designed with ports shaped and adjusted identically. . . . Furnace temperatures could be raised or lowered without affecting furnace atmospheres by means of this one valve."—H. L. Jenkins, North American Mfg. Co.

1930. "The first multiple-recording direct-pressure direct-reading engine indicator with electrically-operated sampling valves. . . . could be installed at a convenient position for the operator, pressure connections from sampling elements to the recording units being small tubes the length of which was not critical."—Claude E. Cox, President, Commercial Research Laboratories, Inc.



1930. "The first direct-recording multiple engine indicator using the balanced pressure principle with balanced diaphragm units installed in each cylinder. The chart moved slowly in response to pressure changes so that the pressure-time diagrams could be observed while being drawn. The chart was of waxed paper and the diagrams were made by spark perforations . . . easily read without the use of transmitted light."—Claude E. Cox, President, Commercial Research Laboratories, Inc.

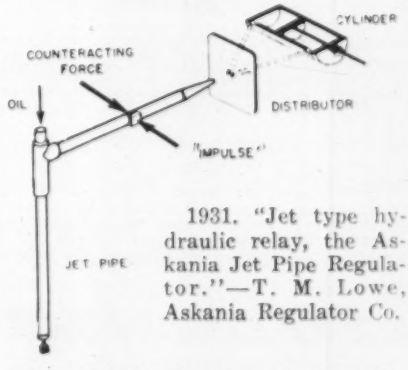
1931. "The Foxboro Uniform Flow Scale Meter was produced."—Robert Barton, The Foxboro Co.

1931. "Indirectly-heated power output pentodes . . . introduced commercially . . ."—E. C. Thompson, for Sylvania Electric Products, Inc.

1931. "Bodine introduced 'Type NSY-12R' synchronous motor . . . application in instruments and cycle timers."—W. M. Yogerst, Bodine Electric Co.

1931. "Working agreement made between S&K and Rotawerke to manufacture and sell Rotameters in U.S.A."—H. W. Gripton, Schutte & Koerting Co.

1931. "... development and manufacture of gas analyzing units for . . . tuning automobile engines . . . marketed under the name of 'Power Prover' . . ."—J. A. Stein, Chief Engineer, Bacharach Industrial Co.



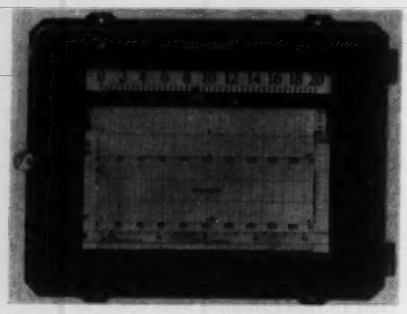
1931. "Jet type hydraulic relay, the Askania Jet Pipe Regulator."—T. M. Lowe, Askania Regulator Co.

1931. Photocell. "For sixty years scientists had been fascinated by the photoelectric phenomenon. Its possibilities never fully attained until Weston set out to make a cell of its own in 1928. In three years Weston developed the 'Photronic' Cell, . . . the first practical, stable photocell of the self-generating dry-disk type."—Philip Barnes, Weston Electrical Instrument Corp.

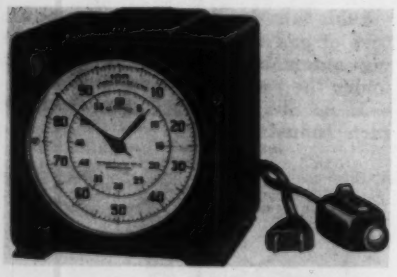
1931. "The first commercial cathode-ray tube is produced by Allen B. Du

Mont. From June 1931 until January 1932, Du Mont designed, made and tested many experimental types of cathode-ray tubes, finally evolving the broad principles for the electrostatic-deflection tubes now in general use throughout the world for oscillographic and allied purposes."—J. H. Ruiter, Allen B. Du Mont Laboratories.

1931. "First successful installation of automatic pH recording equipment used the antimony electrode and L&N potentiometer recorder for measuring pH on paper machines and sugar refineries. Automatic pH control was used later in this same year. These were the forerunners of thousands of industrial pH recording and controlling installations. It proved that continuous measurement of pH could be performed about as simply, as reliably and as accurately as temperature measurement."—H. M. Parshall, Leeds & Northrup Co.

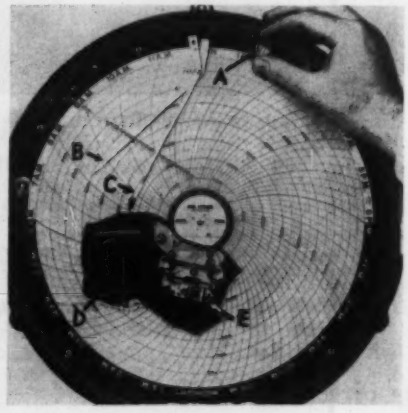


1931. ". . . the first electronic potentiometers on the market. This 'Celectray' line of pyrometers was the first to embody the photoelectric principle of continuous balance."—George Terhune, C. J. Tagliabue Mfg. Co.



1931. Precision Electric Timer. ". . . the late L. P. Dorsett developed . . . timer adaptable to automatic start, stop and reset . . . accuracy of ±0.001 second in some models . . ." — H. P. Blake, Standard Electric Time Co.

1931. "First industrial use of the L&N 'Rayotube,' a total-radiation temperature detector, . . . the first thermopile temperature detector suitably rugged for heavy industrial service. Its use in conjunction with the L&N potentiometer recorder opened up new fields of industrial temperature measurement and control, . . . (Photo shows 'Rayotube' for measuring the temperature of hot billets in transit.)" — H. M. Parshall, Leeds & Northrup Co.



1931. "First general use of mercury switches in Brown controllers. Formerly, . . . two faults (1) control switch points oxidized, stuck, or became dirty and ineffective; (2) arcing of control switches presented a hazard . . . Mercury switches overcame both of these faults . . . other improvements added to mechanical potentiometer, notably, 'Synchro-Balance' printing mechanism which replaced the old cyclic printing systems, . . . In addition, thermocouple burn-out protection was added to both millivoltmeter and potentiometer type controllers. . . ."—C. C. Roberts, Brown Instrument Co.

1931. "American introduced the safety spring on Self-operated Temperature Regulators which prevented damage to the instrument should it be subjected to temperatures beyond its range. American introduced the 'Washograph,' a combined temperature and liquid level recorder to record operation of a laundry wash wheel. It showed at a glance whether or not the washing formula was being followed by the operator."—S. Goodwin, Manning Maxwell & Moore.

1931. "Fisher 'Wizard' Pilot . . . the first pressure regulator to use a Bourdon tube to operate an orifice-nozzle combination large enough to operate a diaphragm-motor valve directly . . ."—J. J. Mullen, Fisher Governor Co.

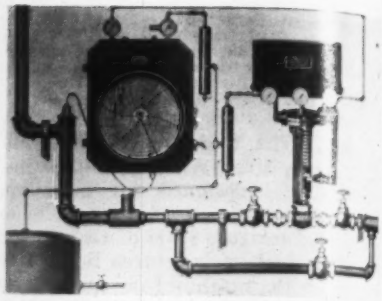


Fig. 1

1931. "Up to this time controllers were of the single response type. As processes became more and more involved, it was apparent that an additional control effect was necessary to compensate for load changes. As a result, the 'Dubl-Response' control system was developed (Fig. 1). The first response, originating in the conventional proportional response controller, was pneumatically transmitted to the 'Dubl-Response Control Unit' mounted on the diaphragm valve (Fig 2). The second response was proportional to the magnitude of the load change and caused the valve to assume any position necessary to satisfy load conditions while maintaining control at the original setting point. Because the 'Dubl-Response Control Unit' was directly connected to the valve stem it provided for the first time Precision Valve Action and became the forerunner of the Taylor 'Precisor' . . . [see 1935]."—C. S. Conner, Taylor Instrument Companies.

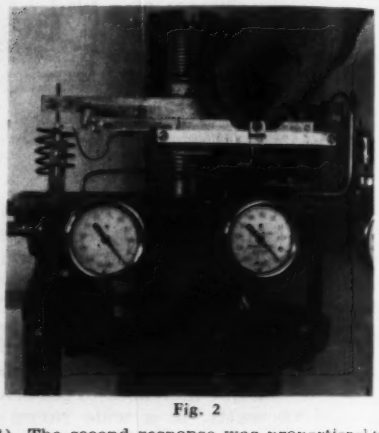
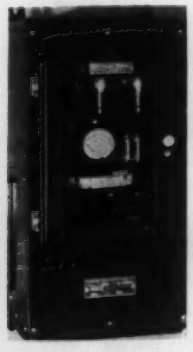
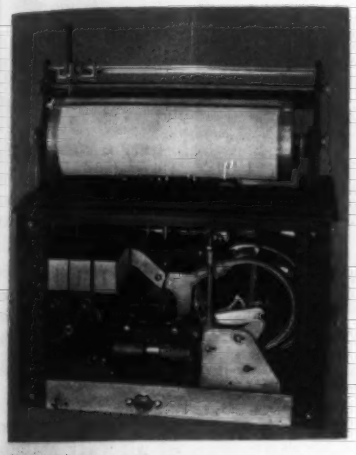


Fig. 2



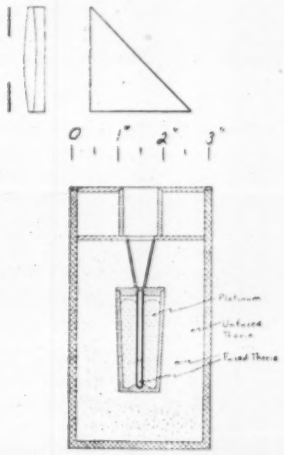
1931. "Telemeter . . . Transmitter employed any standard measuring element . . . two heavy-duty triodes and a contact-making device on the scale to translate measurement into proportional milliamperes; calibration entirely independent of tube characteristics; no calibration drift with temperature change or tube age. Receiver was a recording milliammeter . . . calibrated for the primary measuring element. This telemeter is the only Esterline-Angus product containing vacuum tubes. Electronic circuits have purposely been omitted as integral parts of the company's recorders because most vacuum-tube devices change their characteristics with temperature and age. They are usually not suitable in recorders which must operate unattended for long periods . . . "—Don Brewer, Esterline-Angus Co.

1931. Impulse-duration Method of Telemetering. "Our 'Chronoflo' was conceived on an entirely new principle of telemetering . . . the fundamental idea . . . is the measurement of electrically-transmitted values of flow, pressure, levels, etc., by the length of time of the transmitted signals. The exactness possible in the measurement of time duration accounts for the inherent accuracy of this system." — C. G. Richardson, Builders-Providence, Inc.



1931. "Introduction by BLW of the Templin Autographic Stress-Strain Recorder. Previously, stress-strain data were read from indicating instruments and plotted by hand. . . . The recorder produced a more accurate curve automatically . . . A Bourdon tube connected to the hydraulic load weighing system of the Baldwin-Southwark testing machine controls chart-drum rotation . . . The deformation-recording stylus is controlled by a strain follower attached to the specimen and connected to the recorder through a Selsyn system."—M. G. Van Voorhis, for Baldwin Locomotive Works.

1931. Precision A-c. Ammeter. "This composite-coil electrodynamic instrument, invented at the NBS . . . comprises an astatic arrangement of pairs of fixed and suspended moving coils. Interleaved windings are so arranged for connection that a-c. torque in one set may be balanced against d-c. torque in another set. By means of a built-in potentiometer, d-c. values may be compared with a-c. to better than 0.1% so that this type of instrument is useful for accurate measurements of current and power and in checking indicating instruments."—Hugh Odishaw, National Bureau of Standards.



1931. The Standard of Light. "In 1908 Waidner and Burgess had suggested a blackbody immersed in a bath of freezing platinum as a standard of light . . . [desirable features]. In 1931 it was realized experimentally at the NBS. . . . The platinum (99.997% pure) is contained in a thorium oxide crucible . . . heated by means of a high-frequency induction furnace. The light from the small hollow enclosure, also of thorium oxide, passes through a prism and lens and is then compared in intensity with that of other light standards. . . . The brightness of the blackbody is 58.84 candles per square centimeter when the platinum is freezing. This standard of light has been adopted internationally and became the Fundamental Standard on January 1, 1947."—Hugh Odishaw, National Bureau of Standards.

1932. "Carbon mandrel process introduced to produce tapered tubes of reasonable accuracy." — H. W. Gripton, Schutte & Koerting Co.

1932. "Foxboro acquired the Wilson-Maeulen Instrument Company, New York, adding a line of pyrometric instruments."—Robert Barton, The Foxboro Co.

1932. "Boiler Water Level Recorder . . . gave a complete picture of the rate of change of water level throughout a larger range of the boiler drum than was practical with a gage glass."—E. B. Bossart, Bailey Meter Co.

1932. "The first DuMont cathode-ray oscillograph, "Type 127,' . . . was composed of two units: a case containing the power supply, sweep circuits and controls; and an adjustable holder for a 3" cathode-ray tube."—J. H. Ruiter, Allen B. DuMont Laboratories.

1932. "Escapement Type Integrator announced. This gave an indication of total flow in pounds or gallons by a six-digit register counter . . . adjusted the integrated total to the prevailing rate of flow four times each minute."—E. B. Bossart, Bailey Meter Co.

1932. "First high-vacuum low-drop rectifier tube, replacing mercury vapor rectifiers . . . introduced commercially by Sylvania Electric. . . . eliminated rectifier noise and cold weather starting limitations of the earlier mercury vapor type."—E. C. Thompson, for Sylvania Electric Products, Inc.

1932. The Thermistor. "Bell System engineers developed the Thermistor. Because of their unusually high negative temperature coefficient of resistivity Thermistors are extremely useful as measurement and control devices where temperature is an important variable." —F. H. Lovette, Historian, Western Electric Co.

1932. "The Exax line of volumetric glassware was redesigned, provided with fused-on blue glass filler in the lines and numbers and provisions was made to retest every piece individually. This was the first offering of a complete line of quality volumetric apparatus of guaranteed accuracy." — J. J. Moran, Kimble Glass.

1932. "The Foxboro Air Weight Controller, which delivers to the cupola a predetermined weight of air, in proportion to the weight of coke and iron, and regardless of barometric, line-pressure, and temperature variations, was developed. It is now standard equipment with leading foundries in North America and many other countries."—Robert Barton, The Foxboro Co.

1932. "The first industrial-type glass pH electrode was made available by L&N. . . . pH measurement took a great stride forward in the industrial world. . . . The inherent difficulties of the various electrode systems previously used for pH measurement had seriously limited industrial application . . ." —H. M. Parshall, Leeds & Northrup Co.

1932. "Air-operated Combustion Control introduced. This was the first complete combustion control system with the automatic fuel-air ratio feature which was sufficiently simple and low in cost to be within reach of small industrial boiler plants. . . . Pneumatic controllers were also applied to process operations outside the boiler room."—E. B. Bossart, Bailey Meter Co.

1932. "In conjunction with Corning Glass Works . . . Mr. Charles R. Palmer went to Germany and other countries to improve upon the method of making 'red-reading-mercury' glass tubing for the benefit of the users in U. S. At that time, he made an agree-

ment with a German firm to make such tubing for the foreign trade . . ."—A. E. Honningford, Palmer Thermometers Inc.

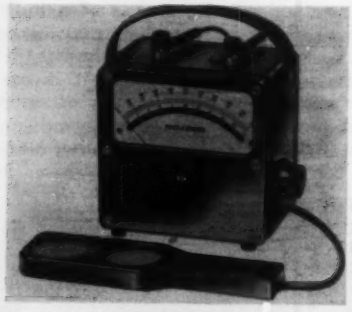
1932. High-precision Resistance Thermometer. "In 1932, L&N produced an even more precise resistance element, after a design by Dr. Meyer of the National Bureau of Standards. This present platinum thermometer is the same basic type as that used to define the International Temperature Scale from —190°C. to 660°C."—H. M. Parshall, Leeds & Northrup Co.

1932. "Ashcroft Gages were first to use 14% chrome nickel molybdenum stainless steel Bourdon tubes to provide superior corrosion resistance and improved tube characteristics. . . . American introduced a metal case Submarine Thermometer for use by the Navy which enabled them to reduce breakage. . . ."—S. Goodwin, Manning, Maxwell & Moore.

1932. ". . . the first Magnetic Clutch Flow Meter and Flow Controller. . . . an important contribution because pressure-tight bearing (stuffing box) source of friction was eliminated. With all working parts submerged in mercury, the instrument could be applied directly to ordinarily corrosive fluids and oils without the interposition of a sealing chamber."—George Terhune, C. J. Tagliabue Mfg. Co.

1932. "Adjustable Orifices introduced. These simplified the accurate metering of flows which vary according to seasonal loads. . . . have greatly simplified the testing of aircraft carburetors." —E. B. Bossart, Bailey Meter Co.

1932. "Leeds Recorder was improved by redesigning the balancing mechanism, and became the 'Micromax' instrument used today in thousands of industrial and laboratory applications for measuring, recording and often controlling temperature, pH, [etc.]"—H. M. Parshall, Leeds & Northrup Co.

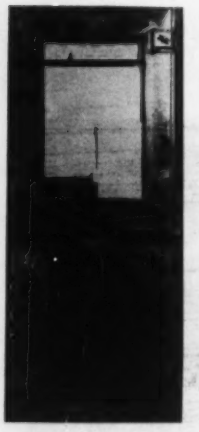


1932. Direct-reading Illumination Meter. "Replacing complicated devices depending upon eye comparisons for measuring light, the 'Photronic' Cell was combined with a Weston Instrument movement to provide the first direct-reading illumination meter."—Philip Barnes, Weston Electrical Instrument Corp.

1932. "L&N 'Centrimax' flowmeter was developed . . . unique method: measuring flow by integrating first and then recording rate of flow, . . . provides substantially higher accuracy than any other type of industrial flowmeter.B. J. Wilson, of L&N, later received the Longstreth Medal from the Franklin Institute for this development."—H. M. Parshall, Leeds & Northrup Co.

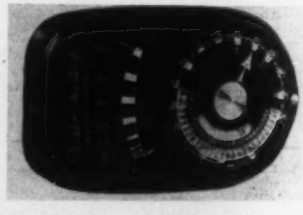
1932. "Pneumatic 'Free-Vane' System of automatic control was developed and originally patented by The Bristol Co. . . . The basic control unit consists of a thin vane which passes freely between two opposing jets of air to produce a throttling action on the control mechanism. There is no retarding or braking action on the measuring element above, below, or at the control point. . . . Dead space, lost motion, and air friction were, for all practical purposes, eliminated."—G. P. Lonergan, The Bristol Co.

1932. "The deForest Scratch-recording Strain Gage, which BLW is licensed to manufacture, was and is the smallest, lightest and lowest-cost recording strain gage ever devised. It weighs less than two grams, and records deformations of 0.0001″ to 0.050″ by a scratch pattern on a small polished chrome-plated target . . . record may be examined and measured under a filar eye-piece microscope or photographed at high magnification. —M. G. Van Voorhis, for Baldwin Locomotive Works.



1932. "First high-speed industrial recording instrument, 'Speedomax,' successfully applied to the measurement of temperature of moving billets . . . speed of 1.5 seconds across the scale,...first to employ a vacuum-tube amplifier for detecting potentiometer unbalance and commanding the recording pen . . . this pioneer high-speed recorder has led to the development of a complete line of 'Speedomax' instruments for industrial and laboratory use."—H. M. Parshall, Leeds & Northrup Co.

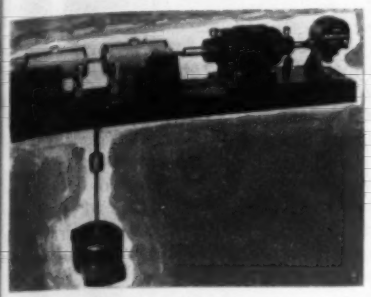
1932. "Lawrence Sperry had conceived the notion of aircraft stabilization and, as early as 1914, had won a French safety contest for a 'stable plane' with an instrument he developed. His was an idea before its time, . . . Not until larger, heavier planes were used did the need again become apparent. It was then that the Sperry Gyropilot was developed. In 1932 Wiley Post, flying his 'Winnie Mae,' made a round-the-world solo flight, the first Gyropilot allowing him to catch an unheard-of catnap while it guided the plane. It was a direct descendant of the components of Sperry's original 1914 stabilizer—the Directional Gyro and the Artificial Horizon." — C. H. Jones, Sperry Gyroscope Co.



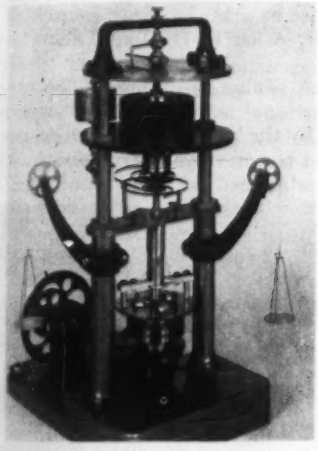
1932. Exposure Meter. "The 'Photronic' Cell, combined with a fundamental instrument and a calculator based on a new Weston film rating system, quickly superseded older eye-judgment systems, thus providing the first really accurate device for calculating camera exposures."—Philip Barnes, Weston Electrical Instrument Corp.

1932. Heavy Water. "On Dec. 9, 1931, E. W. Washburn and E. R. Smith of the NBS started experiments on the isotopic fractionation of water which quickly led to the first preparation of heavy water and to the discovery of the electrolytic method for its production. . . . Starting from this discovery, the preparation of pure heavy water in

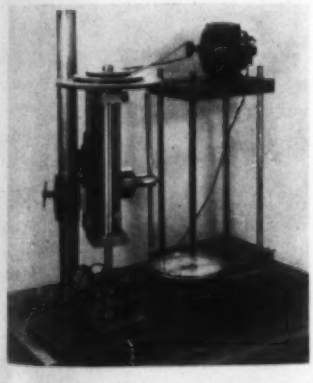
commercial quantity, and consequently also of pure deuterium, became immediately possible by the continuous fractional electrolysis of ordinary water." —Hugh Odishaw, National Bureau of Standards



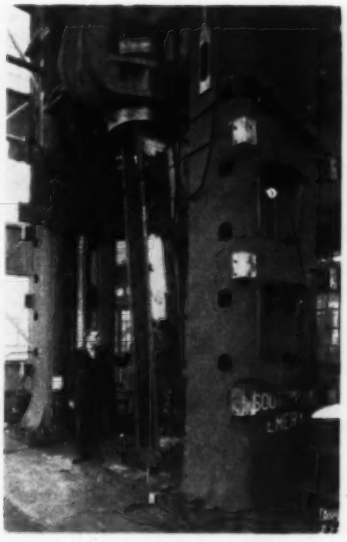
1932. "The R. R. Moore rotating beam type of fatigue machine, originally operating at 1800 rpm. BLW obtained a license to manufacture it and converted it to a high-speed machine operating at 10,000 rpm. Specimens can be loaded to 200 in.-lb. . . ."—M. G. Van Voorhis, for Baldwin Locomotive Works.



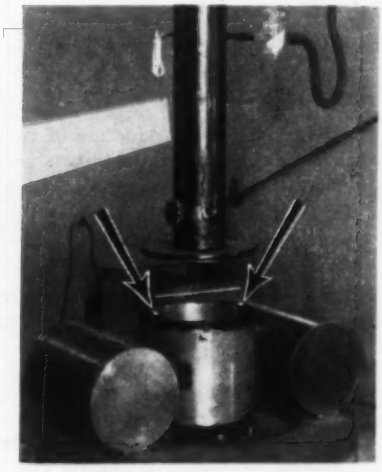
1932. "Herschel Oiliness Machine—A machine developed by the NBS for measuring the coefficient of friction with various lubricants."—Hugh Odishaw, National Bureau of Standards.



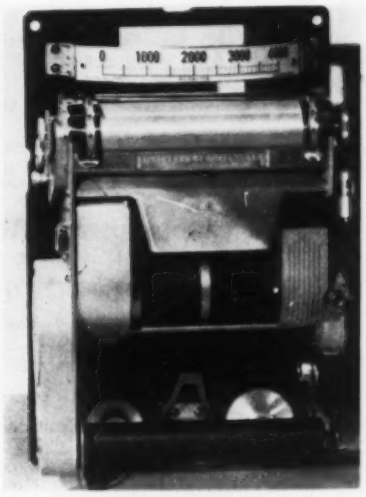
1932. "Journal Bearing Film Pressure Apparatus designed at the NBS measures film pressures at practically all points on a bearing surface under varying conditions of load, speed, and lubricant viscosity." — Hugh Odishaw, National Bureau of Standards.



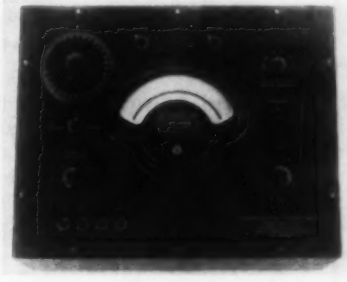
1932. "The 4,000,000-lb. Southwark-Emery Universal Testing Machine, built by BLW for the University of California, was the largest precision testing machine in the world in two respects: loading capacity and size of specimen accomodated. . . . Compression specimens up to almost 10 ft. square and 33½ ft. long, and tension specimens up to 33½ ft. long (less machine stroke) . . ."—M. G. Van Voorhis, for Baldwin Locomotive Works.



1932. Apparatus for Determination of the Constant of Gravitation. "The immense popular interest in the constant of gravitation arises from the fact that it enters into the evaluation of the mass, or 'weight,' of the earth. The photograph of the NBS-developed apparatus . . . shows the mass-sensitive torsion pendulum partly lifted from its vacuum-tight case. The pendulum consists of platinum spheres [arrows] supported from a crossarm which in turn is suspended from the top of the supporting chimney. Motions of the pendulum, caused by the attraction of the large movable steel cylinders on the platinum spheres, are recorded photographically with the aid of a mirror attached to the pendulum."—Hugh Odishaw, National Bureau of Standards.



1932. "New 'Model AW' recorder was a 6" strip-chart instrument . . . principal features: a greater ruggedness than previous models, with separately designed interchangeable and replacable components. Individual features: multiple-speed interchangeable chart drives (illustrated); interchangeable measuring elements; electrical elements removable without breaking soldered connections; interchangeable cases for switchboard, wall or portable; provision for chronograph pens on either side of chart; fool-proof inking system. Electrical measuring elements . . . greatly improved by use of torque springs instead of suspension wires . . . designed to withstand a 5000-volt breakdown test . . . Both synchronous-motor and spring-clock chart drives were designed to give nine paper speeds, from ¾" per hour to 6" per minute . . . and as high as 3" per second with an external motor."—Don Brewer, Esterline-Angus Co.



1932. Microvolt Potentiometry. "Poggendorff's 'second method of compensation' . . . useful in the case of very low voltages where contact resistance and thermal emf's require especial consideration . . . adjustment of a potential difference between two tap-off points on a known fixed low resistance . . . accomplished by providing an adjustable resistor in series with the fixed resistor and a suitable voltage source. The current through the low resistance is read on a high-grade indicating instrument which thereby serves to measure the low-voltage drop across the resistor. The device is called a Lindeck-Rothe element. . . . The first potentiometer (illustrated) was provided with a single Lindeck-Rothe element and a special design of tapped resistor to give multiple ranges and by using thermocouples permits a precise determination of small temperature differences . . . refinements in design and incorporate details necessary to insure adequate thermal isolation of components in order to avoid parasitic thermoelectric effects."—Hugh Odishaw, National Bureau of Standards.

1932. "Contact-making instrument was added to Esterline-Angus line . . . standard recorder cases and measuring elements, but instead of a chart drive

. . . adjustable high and low contacts . . . In that same year, d-c. measuring elements in 'Model AW' were designed for ranges as low as 0-5 milliamperes, . . . the most sensitive direct-writing recorder at that time . . . became available just when the science of electronics was being developed . . . widely used to record outputs of vacuum-tube circuits." —Don Brewer, Esterline-Angus Co.

FIFTH "GALLERY"

From Industrial Adoption *of* Electronics

(Arbitrarily, from January 1933)

to Outbreak *of* World War II *in* Europe

(Sept. 1, 1939, but here including items to end of 1939)

1933. "The Foxboro Co., Ltd., began manufacturing operations in Canada." —Robert Barton, The Foxboro Co.

1933. "Vacuum Pumps with 'Duo-Seal' by-pass to carry off last increment of gas that escapes the exhaust port."—H. E. Brown, W. M. Welch Mfg. Co.

1933. "The first multiple-stage variable-area flowmeter with machined-in guides and logarithmic scales."—Claude E. Cox, President, Commercial Research Laboratories, Inc.

1933. "The Greiback Vacuum-tube Voltmeter . . . featuring high sensitivity and true RMS response. (No longer being manufactured)"—A. J. Lush, President, Rawson Electrical Instrument Co.

1933. "Foxboro produced the Bell-type Meter, particularly adapted for low pressure measurement, thus rounding out a line of high-accuracy flow-measuring instruments."—Robert Barton, The Foxboro Co.

1933. "Standard 6.3-volt heater tube . . . introduced commercially to replace earlier types with 5- and 2.5-volt heaters requiring series resistors and excessive battery drain . . ."—E. C. Thompson, for Sylvania Electric Products, Inc.

1933. "This model of motor frame [see 1931] was expanded to include split phase, polyphase, series, shaded-pole, shunt and capacitor motors. Most have been applied on instruments and control devices."—W. M. Yogerst, Bodine Electric Co.

1933. "The L&N Precision Air Capacitor was developed. This standard capacitor was direct-reading, highly accurate, had low loss and could be set up to the desired value with great precision." — H. H. Parshall, Leeds & Northrup Co.
Barton, The Foxboro Co.

1933. "American introduced the use of atomic hydrogen welding methods in making stainless steel systems for mercury-filled dial and recording thermometers. Longer life and greater resistance to corrosion resulted." — S. Goodwin, Manning, Maxwell & Moore.

1933. "Introduced 'Model C' portable 'Universal' Current Transformer . . . nine different ranges, five of which obtained by means of a wound primary and four by looping current-carrying conductor through an opening in core . . ."—Don Brewer, Esterline-Angus Co.

1933. "Stopcock plugs with polished bores were provided. (Previously, holes were drilled. The walls of the holes were rough and the edges of the openings were frequently chipped. To hide this defect, openings often were countersunk, but this offered the possibility of trapping air.)"—J. J. Moran, Kimble Glass.

1933. "Foxboro brought out the Potentiometer Stabilog Controller, operating from thermocouples, combining a null method fixed-setting potentiometer pyrometer with Stabilog automatic control, making proportioning air-operated control with automatic reset available for temperatures up to 2800°F."—Robert Barton, The Foxboro Co.

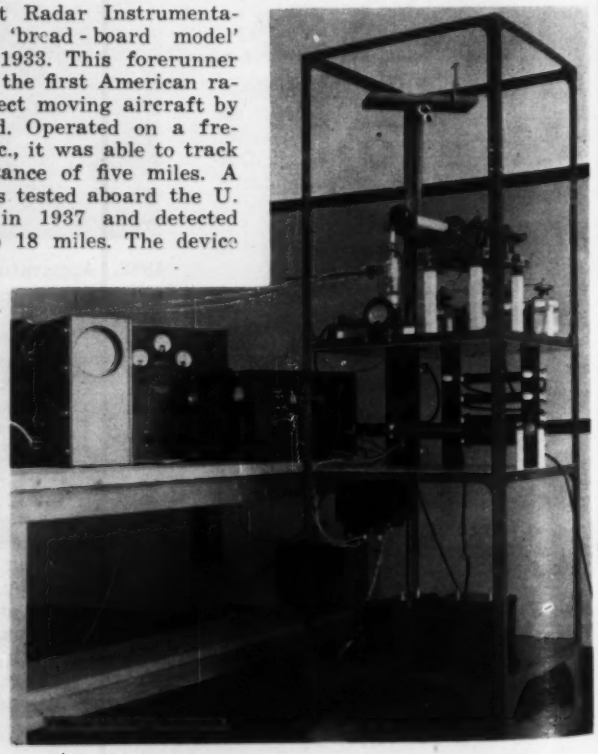
"1933 marked the introduction of the first electric thermometer controller using mercury switches . . . marked a major improvement in control actuation for pressure type thermometers in that the mercury-type control switches were operated by a motor-driven mechanism. Thus, free movement of pen-arm or pointer was permitted at all times."—C. C. Roberts, Brown Instrument Co.

1933. "Apparatus for Testing Gas Lubricants. To measure the load-carrying capacity of gas lubricants, two cylindrical surfaces are driven and loaded in such a manner that they simulate the action of gear teeth. This apparatus, designed at the NBS, played an important part in the development of the present SAE Extreme-Pressure Lubricants Testing Machine."—Hugh Odishaw, National Bureau of Standards.

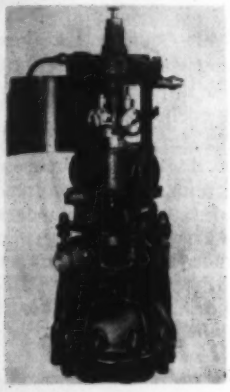
1933. "DuMont introduced the Macneil amplifier, current sensitivity 0.4 microampere, for the operation of string torsion galvanometers. July: DuMont produced the first laboratory-grade cathode-ray oscillograph . . . a rack-type instrument with a 5" tube, also available with a 9" tube. It had a linear range sweep of 10 to 5000 cycles and was hailed at the time as a marked advance in precision equipment."—J. H. Ruiter, Allen B. DuMont Laboratories.

1933. Valve Positioner. "The precise proportional action with the reset, provided by the 'Stabilog' Controller, necessitated better valve characteristics than were standard at this time; and the Foxboro 'Stabilflo' Valve, with equal percentage characteristics, appeared in 1933. In order to obtain the full benefit of this valve, a precise positioner was developed. This was the Foxboro 'Valvactor,' also a product of 1933."—Robert Barton, The Foxboro Co.

1933. World's First Radar Instrumentation. "Experimental 'bread-board model' pulse transmitter of 1933. This forerunner of modern radar was the first American radio instrument to detect moving aircraft by the pulse-echo method. Operated on a frequency of about 30 Mc., it was able to track aircraft up to a distance of five miles. A later development was tested aboard the U. S. Destroyer *Leary* in 1937 and detected ships and aircraft to 18 miles. The device was designed and built by Dr. R. M. Page and Mr. L. C. Young working under the supervision of Dr. A. Hoyt Taylor at the NRL. . . . To the best of our belief the illustrated model is the first successful pulse-radar to be operated anywhere in the world."—M. E. Jansson, Technical Information Officer, Naval Research Laboratory.

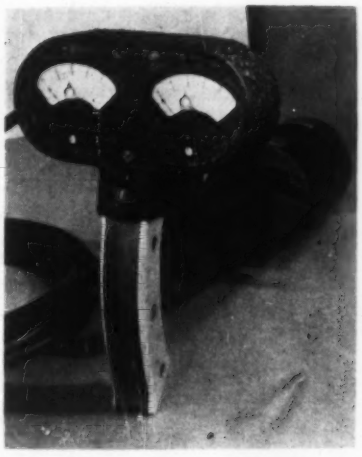


1933. Photocell Correction Filters. "Early photoelectric illumination meters gave full accuracy in light readings when measuring sunlight or tungsten, but required correction factors when used on other light sources. In 1933 Weston introduced the 'Viscor' filter, which gives the photocell essentially the same spectral sensitivity as the human eye. Thus the 'Viscor' equipped Weston Illumination Meter could now be used on all light sources, regardless of their color composition." — Philip Barnes, Weston Electrical Instrument Corp.

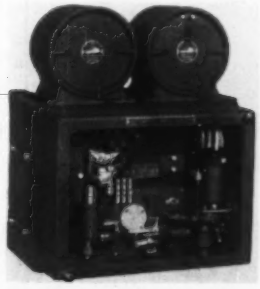


1933. "Pneumatic tachometer for measurement and control of viscous fluids, including fuel oil—the Askania 'Transometer.' "—T. M. Lowe, Askania Regulator Co.

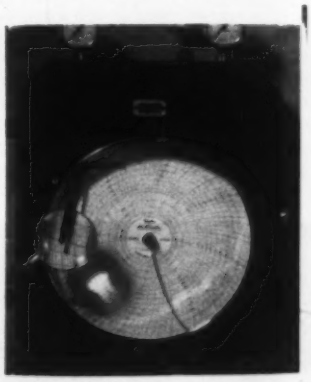
1933. "Development of all frequency standards now manufactured by American Time Products, Inc., dates back to need arising before International Olympic Games held in California in 1932. Officials sought a dependable timing instrument to record indisputably the results of events for acceptance as World's records . . . The Western Electric Co. developed such a timing apparatus, but it was not portable and the time pulses were relayed over telephone wires from New York . . . Continued work resulted in a portable Frequency Standard . . . Charles H. Fetter who was in charge of this work at Western Electric founded and became president of American Time Products, Inc., which continued the further development . . . 'Watchmaster' (illustrated) . . . now used by watch manufacturing companies and jewelers everywhere. The Timing Standard is being used in many Government departments and also in industry for timing various plant and laboratory operations . . . guaranteed accuracy of 1/1,000th of 1%, and calibrated against a standard accurate to one part in ten million."—H. M. Alexander, American Time Products, Inc.



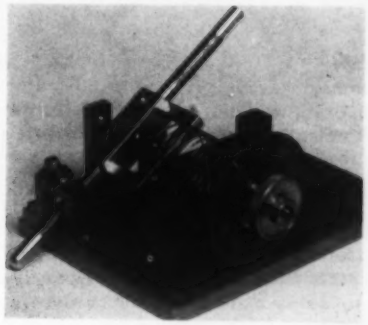
1933. "The first commercial magnetic thickness gage, for gaging the wall thickness of cylinder blocks by contact with the inside machined surface only." —Claude E. Cox, President, Commercial Research Laboratories, Inc.



1933. "Automatic Oscillograph. The 'PM-13' 6-element automatic oscillograph was the first self-contained quick-starting automatic oscillograph . . . capable of automatically recording transient or unanticipated disturbances; after which it automatically reset itself for the next disturbance, whether occurring immediately or at some later time. It can record nearly 100 operations without intermittent attention."—K. R. Geiser, Gen'l Eng'g and Consulting Lab., General Electric Co.



1933. "A greater reformation took place in design construction with the development of the '56R Series' instruments. This included a new type of die-cast case, a continuous method of sensitivity adjustment, reverse action without additional parts, and a new system of linkages which minimized pen drag." —C. S. Conner, Taylor Instrument Companies.



1933. Magnetic Balance. "This instrument was designed by Sanford of the NBS primarily for the inspection of austenitic steel. It was later modified and developed by Brenner of the Bureau for the measurement of the thickness of nickel coatings on a non-magnetic base or of non-magnetic coatings on a magnetic base (see the 'Magnegage,' 1935)."—Hugh Odishaw, National Bureau of Standards.

1933. "The 'Cathautograph' . . . was an ingenious adaptation of cathode-ray technique . . . flashing the written word or sketch over wires or radio. A pencil, connected by levers, works across two resistors to control two sets of plates of a cathode-ray tube. The tube is provided with a 'memory' type screen or one with a very slow rate of decay, so that the trace remains luminous for 30 seconds or so . . . At the transmitting end, the alteration of the two resistance values correspondingly shifts the cathode-ray beam across the screen of the receiver. As many as ten words can be seen on the screen at one time. As the eleventh word is written, the first word fades out. The 'Cathautograph' was a startling innovation."—J. H. Ruiter, Allen B. DuMont Laboratories.

1934. "Foxboro-Yoxall, Ltd., began operations in England."—Robert Barton, The Foxboro Co.

1934. "*E/M* apparatus by Hoag for determining the ratio of the charge and the mass of the electron."—H. E. Brown, W. M. Welch Mfg. Co.

1934. "Bailey 'Galvatron' announced. This was the first potentiometer pyrometer employing an electronic circuit."—E. B. Bossart, Bailey Meter Co.

1934. "Smoke Density Recorder . . . one of the first boiler instruments to use an electronic measuring circuit."—E. B. Bossart, Bailey Meter Co.

1934. "Vacuum Gage by DuBrovin. A direct-reading vacuum gage enabling direct reading to within about 0.01 mm." —H. E. Brown, W. M. Welch Mfg. Co.

1934. "First precision bore tapered tubes used in American-made Rotameters. They were imported from Jena Glass Works."—H. W. Gripton, Schutte & Koerting Co.

1934. "Purge Interlock introduced. Insured against furnace explosions by witholding fuel feed until the furnace was thoroughly purged."—E. B. Bossart, Bailey Meter Co.

1934. "A. R. L. first opened its doors as a spectrochemical testing laboratory . . . designed and constructed its own instruments . . ." — Gwen Barkelew, Applied Research Laboratories.

1934. "We began the design and building of Special Gages equipped with Indicators in order to meet the demands of our customers for better Gages."—I. A. Hunt, Federal Products Corp.

1934. "Precision valve positioner . . . designed to position the valve stem exactly proportional to controller air pressure changes regardless of valve friction . . ."—C. C. Roberts, Brown Instrument Co.

1934. "Introduction of 'Celectray' Indicating Controlling Potentiometers . . . electronic pyrometers eliminated all motors and other reciprocating parts and had no time lag."—George Terhune, C. J. Tagliabue Mfg. Co.

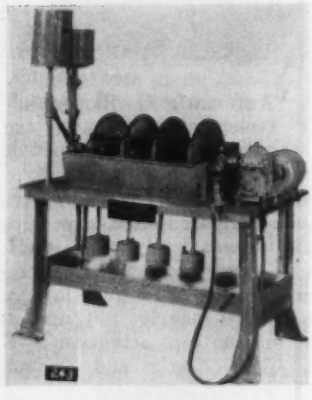
1934. "Two-piece condensers with the connections made by plastic nuts and rubber washers were announced. (Previously, inner tube and jacket . . . joined by rubber tubing or rubber stoppers . . . disassembly for cleaning or replacement of parts was difficult.)"—J. J. Moran, Kimble Glass.

1934. "The first truly portable DuMont oscillographs, 'Type 137' with a 5" tube and 'Type 138' with a 3" tube, were announced in January. These were single-unit instruments, intended primarily for broadcast modulation studies. . . . had controls for frequency adjustment, synchronization, and sweep amplitude. Fall: 'Type 142,' with its 5" tube and four panel controls, was the prototype of present-day general-purpose oscilligraphs."—J. H. Ruiter, Allen B. DuMont Laboratories.

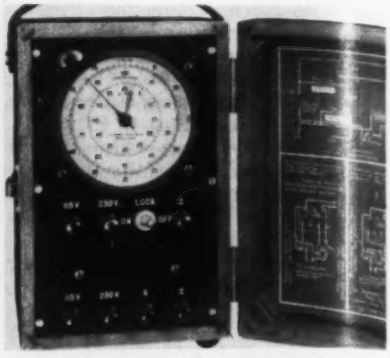
1934. "The 'Model 705' relay was the first commercial relay combining high sensitivity, high contact capacity and ruggedness. It operates on values as low as 0.5 μa. directly from the output of photocells, resistance bulbs and other sources of minute power . . . handles 5 watts at 110 volts on its magnetic contacts."—Philip Barnes, Weston Electrical Instrument Corp.

c. 1934. "Rate-of-change Control Action. The theoretical work begun in 1930 on the use of the derivative function culminated in the production of the 'Impulsator'; and in 1934 the 'Automatic Fireman' (Potentiometer Stabilog with Impulsator) was applied to the control of oil refinery tubular heaters, the first successful application of control to this operation. While the Impulsator differed in detail from the modern derivative, it was definitely a rate-sensing (derivative) action."—Robert Barton, The Foxboro Co.

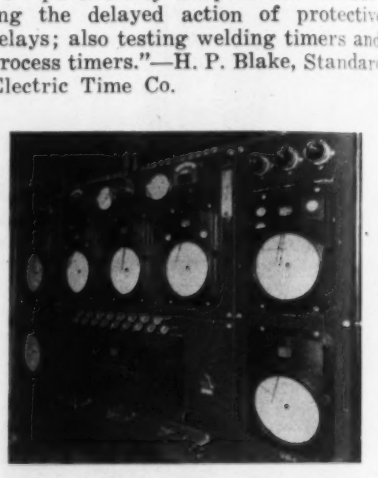
1934. " . . . a new conception of level control . . . 'Uniflow Level Control.' Slow averaging regulation of outflow was made possible by 5-ft. float travel. The magnetic clutch, which TAG had brought out in 1932, permitted . . . transmitting this movement with safety to the external instrument mechanism."—George Terhune, C. J. Tagliabue Mfg. Co.



1934. "The Thwing-Albert Pulp Classifier was developed to separate in a matter of minutes the fibers of different lengths present in paper pulp. With the fiber length known, control of formation . . . becomes a comparatively simple matter."—F. W. Eitzel, Thwing-Albert Instrument Co.



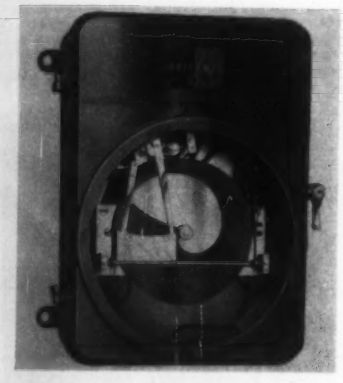
1934. "Cycle Counter. Development of the precision electric timer (1931) led to a further application in the perfection of the cycle counter . . . a specific development for Public Utility Companies. . . . high-speed timer with relays and circuit control equipment . . . accuracy of ¼ cycle . . . moderate cost . . . particularly adapted for measuring the delayed action of protective relays; also testing welding timers and process timers."—H. P. Blake, Standard Electric Time Co.



1934. "Bristol's System of Coordinated Process Control . . . made it possible for the first time to put all of the factors, including mechanical operations, that affected the quality, uniformity, and yield of a product under complete instrument control . . . an engineered combination of automatic control instruments and devices built in the form of a master control station . . . A cycle controller coördinates the efforts of the other automatic-control instruments in the system. Units are shipped in finished form with all piping and wiring complete . . ."—G. P. Lonergan, The Bristol Co.

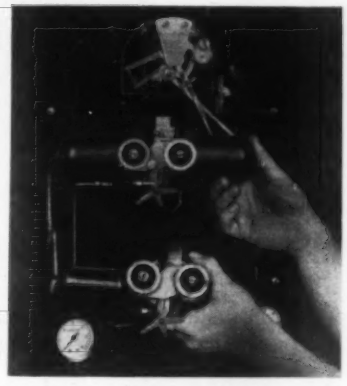
1934. "Autographic thermal expansion apparatus designed and constructed at the NBS to obtain expansion curves photographically or to observe points during tests."—Hugh Odishaw, National Bureau of Standards.

1934. "Ashcroft 'Duragauges' with evenly spaced dials and an accuracy of 0.5% were introduced. These were the first production gages having these two features. Ashcroft was first to use in production a welded joint on steel Bourdon tube gages, even for very low pressures . . . The welded joint is the safest, especially for high-temperature service. (See illustration.) American adapted the general use of stainless steel capillary on all mercury-filled dial and recording thermometers. This provided greater resistance to corrosion and as the manufacture of stainless steel capillary could be controlled, it eliminated the previous danger of plugged lines due to small fissures existing along the inner wall of the capillary."—S. Goodwin, Manning, Maxwell & Moore.



1934. "Bristol's 'Metameter' System of Telemetering . . . required only a simple two-wire circuit or its equivalent between transmitter and receiver, and could be used over privately-owned wires, telephone circuits, and carrier current channels . . . Thousands of these instruments . . . wide variety of remote measurements and automatic control applications . . . transmitters and receivers in some installations more than one hundred miles apart. The Bristol 'Metameter' did more than any other instrument to popularize telemetering."—G. P. Lonergan, The Bristol Co.

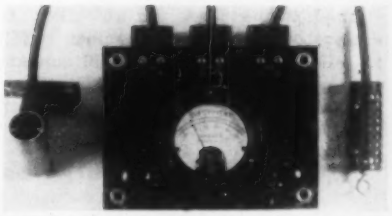
1934. "Introduction of 'Iso-Elastic' (self - temperature - compensating) spring metal obviated need for temperature compensators in instruments. Its high elastic stability, low hysteresis, and low creep, in addition to its thermal compensation, made it ideal for precision apparatus. Introduction of 'Iso-Elastic Springs' using a wire with a rectangular cross-section . . . non-proportional deviations of less than 0.01%. . . . Maximum error from temperature variations, non-proportionality between load and deflection, back-error and creep was reduced to less than 0.08%."—E. H. Gibson, John Chatillon & Sons.



1934 "brought industry the ultimate in air-operated process control systems, Brown 'Air-o-Line' controllers . . . the culmination of several years of thorough research and field tests . . . the first precision type controller. The 'Air-o-Line' control unit was: (1) readily interchangeable because of its unit-type construction; (2) easily adjusted to any particular process requirements without interruption of control by means of readily-accessible automatic-reset and proportional-band adjustments; (3) simply changed from a direct- to a reverse-acting controller; (4) unnecessary to make any adjustments for aging or distortion of bellows or diaphragm, because of balanced-pressure type pilot valve; (5) a hermetically-sealed unit, corrosion resistant, dirt-proof, self-compensating for ambient temperature and highly sensitive to the smallest pen or pointer movement. It was so well conceived and designed that it is in active production today, unchanged."—C. C. Roberts, Brown Instrument Co.

1934. "Vibrometer developed at the NBS for the Bureau of Aeronautics, Navy Department, for measuring the amplitude of linear vibration of a single frequency in the frequency range 600 to 3500 cpm. and amplitude range from 0.005" to 0.015". The graduations are in terms of double amplitude. The vibration-sensitive tip is spring coupled with mechanical amplification to the pointer. In making a reading the vibrating pointer is seen, by persistence of vision, at the ends of its travel. The intersection of these two images of the pointer determines the reading."—Hugh Odishaw, National Bureau of Standards.

1934. "All-glass construction adopted for L&N gas analysis cell, ended difficulties which for many years had been inherent in automatic gas analysis by the thermal conductivity method. This change from the previous metal analysis cells greatly reduced the amount of corrosion to which the measuring element was subjected in operation. By permitting the use of a saturated gas sample, it eliminated the nuisance and time lag of driers. Surrounding the temperature-sensitive platinum heating element with glass also had the effects of improving the mechanical strength, stability and accuracy of the equipment. L&N gas-analysis equipment has been used to measure hydrogen, oxygen, carbon dioxide, sulfur dioxide, chlorine, ammonia, aceton and many other gases."—H. M. Parshall, Leeds & Northrup Co.



1934. Superheat Meter. "During 1932-34 an electrical resistance thermometer of the unbalanced Wheatstone bridge type was developed by the NBS for the Bureau of Aeronautics, Navy Dep't, to replace the thermocouple type . . . used in airships to measure the difference in lift gas and free air temperature. The instrument shown was constructed in 1934; refinements have since been made. The free air element is at the right, the lift gas element at left."—Hugh Odishaw, National Bureau of Standards.

1934. "Brown engineers adapted the air control systems brought out this year for use with potentiometer type recorders . . . a great forward step in process control by combining the precision of measurements obtained with the potentiometer type of instrument with the accurate control made possible by the new pneumatic control systems. The development by Brown of the first commercially feasible method of providing rate response for air control systems contributed greatly to the accuracy of this type of control. In effect, this was accomplished by means of an ingenious mechanical arrangement which provides a corrective timing action to compensate for process lag. The Minneapolis-Honeywell Regulator Co. which became parent company to The Brown Instrument Company this year, contributed many outstanding advancements in . . . instrumentation. In comfort heating, air conditioning and refrigeration . . . the achievements of 'M-H' are unparalled . . . the 'Weatherstat' which facilitated the control of heating in large buildings; 'Moduflow' which gave home owners the advantages of continuous heat balance; electric motorized valve and damper motors which made available a good electric proportioning control system; [etc.] . . . The development and perfection of the 'Protectorelay' by 'M-H' made automatic oil heating possible . . . was designed to operate electronically as a flame-failure safety device. With luminous flames, a photocell type combustion control (with non-luminous oil flames, a flame-electrode is used) and an electronically-operated relay provide safety shutdown of the oil burner in the event of intermittent or permanent flame failures . . ."—C. C. Roberts, Brown Instrument Co.

1935. "First Recording Rotameter."—H. W. Gripton, Schutte & Koerting Co.

1935. "Foxboro pioneered in the development of Pneumatic Transmission of measurement in industrial instrumentation."—Robert Barton, The Foxboro Co.

1935. "Ashcroft introduced the first Laboratory Test Gage with a guaranteed accuracy of 0.25%. Previously, the best obtainable was 0.5%."—S. Goodwin, Manning, Maxwell & Moore.

1935. "Began production of a line of portable instruments for use in connection with combustion and domestic heating applications."—J. A. Stein, Chief Engineer, Bacharach Industrial Instrument Co.

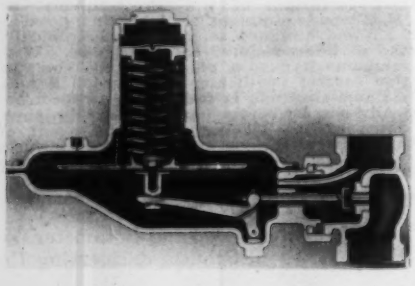
1935. "The first variable-area fuel flowmeter with multiple scales reading in miles per gallon. . . . fuel consumption tests of cars on the road."—Claude E. Cox, President, Commercial Research Laboratories, Inc.

1935. "Southwark-Emery Cement Testing Machines were introduced by BLW to meet special requirements established by an ASTM committee and the industry . . ."—M. G. Van Voorhis, for Baldwin Locomotive Works.

1935. "The Palmer Co. developed a thermometer for dough mixers, where a thermometer was made to register the temperature from a flat surface, inside the dough mixing vat."—A. E. Honningford, Palmer Thermometers Inc.

1935. Cascaded Control. "Foxboro came out with its Ratio Flow Controller. Also produced in this year was 'Pneumaticset' for interrelated instruments. These two innovations were basic elements in the development of the tandem or cascade control system, one of the significant steps forward in control engineering."—Robert Barton, The Foxboro Co.

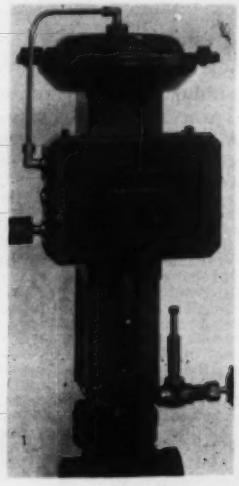
1935. "A. R. L. was commissioned to build a spectrograph and a drum type comparator . . . followed by many others of the same design so it thus holds the distinction of being the first grating instrument made available commercially in the U. S. . . . same year, newly designed projection comparator . . . valuable ideas suggested in principle by Dr. Herman . . . first use of dual projection." — Gwen Barkelew, Applied Research Laboratories.



1935. "Fisher House Service Regulator was the first to incorporate velocity loading and renewable body features." —J. J. Mullen, Fisher Governor Co.

1935. "The Electronic Switch, 'Type 143,' served to place two or more independent signals on the screen of a single cathode-ray oscillograph. The independent signal traces could be displaced for individual detailed study, or superimposed on the same base line for direct comparisons. The DuMont Electronic Switch did more to increase the versatility and value of the cathode-ray oscillograph than any other single development up to this time."—J. H. Ruiter, Allen B. DuMont Laboratories.

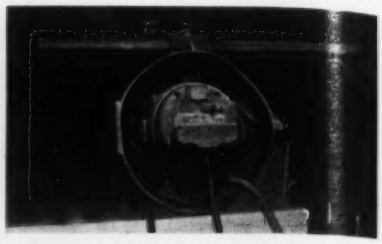
1935. "Special 3-way control disk covered by U. S. Patent and known today as the 'Type C' disk plug . . . overcame inherent disadvantages in the standard 3-way disks: With constant pressure drop through valve, total flow should always be the same regardless of disk position. Standard valve disks do not accomplish this because of a decrease of effective port area in intermediate positions as compared with the two end positions . . . 'Type C' disk features equal total port area regardless of disk position . . . therefore, the same amount of flow through the valve based on equal pressure drop conditions."—E. Wolff, Chief Engineer, H. Belfield Co.



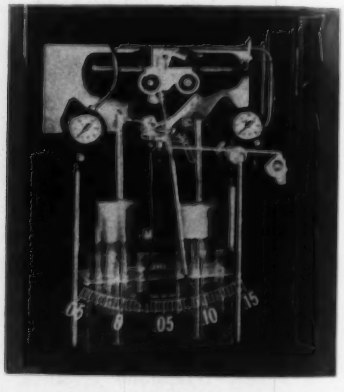
1935. "The Taylor 'Precisor,' a separate unit pioneered and developed by Taylor." — C. S. Conner, Taylor Instrument Companies.

1935. "Until the advent of the Thwing-Albert Formation Tester, there was no way of checking paper formation scientifically, visual judgment being the criterion. With it, paper formation is determined by a beam of light shining against the sample. Light going through the paper falls on a photocell; the reaction of the cell is amplified and interpreted in terms of formation."—F. W. Eitzel, Thwing-Albert Instrument Co.

1935. "The DuMont 'Type 148,' 3" cathode-ray oscillograph, and a 5" job, . . . were the direct forerunners of modern oscillographs. A basically new sweep circuit made possible a 10- to 30,000-cycle range, improved linearity and exceptionally fast return trace. A much improved synchronization circuit locked the sweep with fractions as well as multiples of the wave. The cascade amplifier provided a 1" deflection with 0.2 volt signal. A single knob controlled all switching. As a final refinement, these instruments were provided with the patented calibrated screen scale so characteristic of DuMont oscillographs."—J. H. Ruiter, Allen B. DuMont Laboratories.



1935. "The Brown 'Optimatic' was introduced as the first and only automatic, electronic continuous-recording, optical type pyrometer system, and replaced the old visual-type optical pyrometer formerly used in an attempt to instantaneously measure the surface temperatures of hot objects in the range of 850 to 3,000°F. Its speed of response made it particularly adapted for hot rolling operations in steel mills and other metal processing plants . . . one of the first industrial instruments to embody electronic principles: operation based on the fact that the electrical resistance of a photocell varies with the intensity of the light received . . . Since light intensity depends upon the temperature of the hot body, the 'Optimatic' could be calibrated directly in temperature values. Owing to its instantaneous reaction to temperature changes, the instrument is used to record the surface temperature of hot objects during their rapid progress through the various stages of rolling mill operations and will even show skid marks on the chart record in the early stages of rolling . . . The 'Optimatic' is not limited to rolling mill applications. It is also advantageous in applications involving the pouring of molten material such as iron, steel, glass, etc. and in numerous measurements involving the temperature of incandescent substances."—C. C. Roberts, Brown Instrument Co.



1935. "Furnace Pressure Controller developed . . . precise means to maintain proper balance between entering and discharging gases in a combustion chamber (i.e. correct pressure within furnace) . . . Measuring instrument, of the oil-immersed, inverted-bell type . . . is sensitive to ± 0.0005" of water . . . measured pressure changes are then transmitted to an 'Air-o-Line' pneumatic control system which positions the furnace damper accordingly."—C. C. Roberts, Brown Instrument Co.

1935. "An original application of the 'Electrolimit' gage to a horizontal measuring machine, developed at the NBS, increased the sensitivity of measurement over that of indicators previously used, and permitted the indicator to be substituted for the micrometer as the means of measurement."—Hugh Odishaw, National Bureau of Standards.

Continued on Page 143

1935. "The electronic tube was first applied to temperature control with the 'Wheelco Electronic Principle' . . . Electronic circuit, serving as a link between galvanometer indication and control action, consisted of tuned-grid tuned-plate oscillator *A*, plus direct coupled amplifier *B*. . . . In a tuned-grid tuned-plate oscillator, if the grid and plate circuits are resonated to approximately the same frequency, oscillations will be sustained through the grid-plate capacitance of tube *T*, and its plate current will drop to a low value prescribed by the negative bias resistor *R*. The grid voltage of amplifier tube T_2 is the algebraic sum of E_2 and the voltage drop across the load resistor R_2. When *T* is in oscillation, the grid of T_2 will become positive due to the low plate current flowing through R_2 resulting in a rise

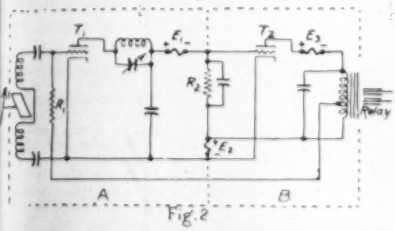
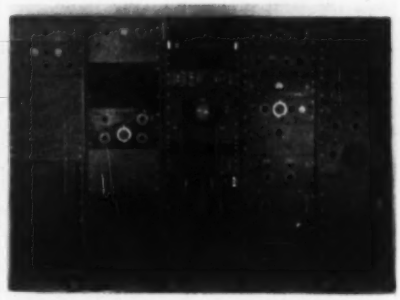


Fig. 2

of T_2 plate current above the pull-in point of the relay. If the tuned-grid or the tuned-plate is deresonated, *T* will stop oscillating and its plate current will rise, increasing the voltage drop across R_2 so as to override E_2 and swing the grid of T_2 negative. The plate current of T_2 will then drop far below the pull-out point of the relay, thus obtaining positive control action. In order to increase sensitivity, regenerative bias is employed. The circuit is entirely a-c.-operated and a single twin-triode tube is used

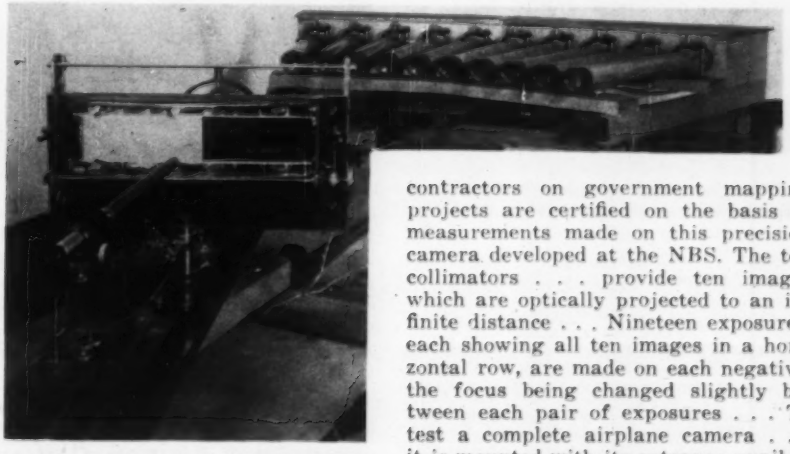
Fig. 3

to simplify the unit. Operation (Fig. 3): Frequency of oscillating current flowing between coils *A*, mounted on setting Lever *B*, is changed when metal vane *C*, mounted on indicating pointer, is moved between coils by slightest change in the variable under control. This change in frequency operates to de-energize a relay and actuate the contacts. Relay is used to operate fuel valves, electric heating loads, etc. . . . With the 'Wheelco Electronic Principle,' the speed of pyrometric control action was greatly increased and an accuracy of 0.006" around the selected control point achieved. The instrument design allowed a theretofore unknown simplicity by eliminating mechanical coupling between indicator and control systems."—E. Schneider, Director of Research and Engineering, Wheelco Instrument Co.

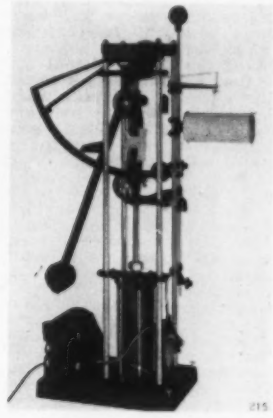


1935. "At the Harvard Medical School the writer had designed elaborate amplifiers and recording systems for oscillography of nerve and muscle potentials [see illustration] . . . Investigations into hearing resulted in the rediscovery of action currents in the brain itself . . . 1 to 40 cps., 10 to 50 microvolts, recorded with cathode-ray equipment and with telegraph and cable recorders borrowed from the communications industry. Great significance was immediately perceived for this method of diagnosis and the Electro-Medical Laboratory, Inc., was founded in this year to provide clinically useful apparatus."—Lovett Garceau, Electro-Medical Laboratory, Inc.

1935. "The G-E High-speed Photoelectric Recorder records anything that can be measured with a basic electric instrument. Temperature . . . is an ideal application . . ."—R. K. Fairley Gen'l Eng'g and Consulting Lab., General Electric Co.



1935. Precision Camera for Testing Airplane Cameras and Airplane Camera Lenses. "All lenses used by civilian contractors on government mapping projects are certified on the basis of measurements made on this precision camera developed at the NBS. The ten collimators . . . provide ten images which are optically projected to an infinite distance . . . Nineteen exposures, each showing all ten images in a horizontal row, are made on each negative, the focus being changed slightly between each pair of exposures . . . To test a complete airplane camera . . . it is mounted with its entrance pupil at the intersection of the axes of the ten collimators."—Hugh Odishaw, National Bureau of Standards.



1935. "The Thwing-Albert Electrohydraulic Tensile Strength Tester was developed. It is a universal tester capable of changing speeds or stopping at any time during a test, and then continuing at the same or any other speed between 1" and 30" per minute . . . could show reproducible results under widely varying conditions, with a smooth application of the load . . . Tests include tension, compression, puncture, shear, tear, flexural rigidity, and fatigue."—F. W. Eitzel, Thwing-Albert Instrument Co.

1935. "The Recording Spectrophotometer, an instrument for color measurement in which a monochromatic light is reflected alternately by a standard and a sample, a pen-and-ink record being made of the difference. The monochromatic

beam is passed through a polarizing and flickering optical system into an integrating sphere where it falls alternately 60 times a second on the sample and the standard. If the light reflected by the two is equal, the phototube sees a constant light level. If, however, the reflectance is not equal, the phototube will see light variation at the rate of 60 cycles a second. The 60-cycle voltage signal from the phototube is amplified and applied to a thyratron stage to drive a small split-field d-c. motor. This "balance" motor is connected through the photometer cam to rotate a Rochon prism which changes the light intensity on the standard with respect to the sample, until the light reflected by the two is equal, at which time the phototubes sees no light variation and stops the motor. The position of the Rochon prism is then a measure of the comparative reflectance of the sample. The recording pen is driven by the same shaft that drives the prism, so that the position of the pen is an accurate measure of the difference in reflectance between the standard and the sample for that wave-length."—W. R. Jacobson, Gen'l Eng'g & Consulting Lab., General Electric Co.

1936. "Foxboro was the first to apply the principle of Pneumatic Loading to roll-type industrial machines."—Robert Barton, The Foxboro Co.

1936. "The first commercially successful instrument for the continuous measurement of density of liquids, using the differential pressure method, was developed."—Robert Barton, The Foxboro Co.

1936. "Bailey Air-operated Automatic Combustion Control installed on ocean and Great Lakes Steamships. These were the first installations of complete marine boiler control."—E. B. Bossart, Bailey Meter Co.

1936. "Ashcroft Gages and American Dial Thermometers were the first to be furnished with stainless steel movements to give longer life and greater corrosion resistance."—S. Goodwin, Manning, Maxwell & Moore.

1936. "Permutit introduced portable 'Ranarex' instruments all dimensions one-fourth those of stationary model . . . for indicating only, not for recording . . . operated on lighting circuit or 6-volt automobile battery."—K. F. Urquhart, for The Permutit Co.

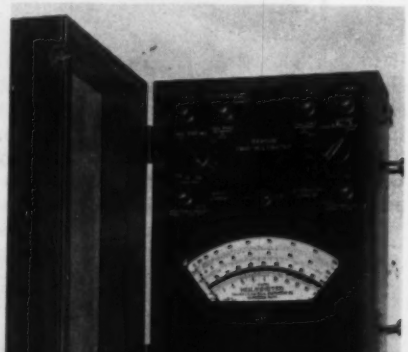
1936. "The Brown 'Moist-o-Graph' was the first moisture content recording and control device for yarns to utilize an electronic circuit for measuring electrical resistance of yarn . . . particularly well adapted for the control of moisture content."—C. C. Roberts, Brown Instrument Co.

1936. "Kimble 'N51-A' glass was produced. This borosilicate glass still is standard for apparatus or containers when maximum resistance to chemical attack is required. Its behavior is described in *RP 1394* of the National Bureau of Standards by Wichers, Finn and Clabough."—J. J. Moran, Kimble Glass.

1936. "Utilizing the principle of flame conductivity, the Wheelco 'Flame-otrol' was the first electronic type combustion safeguard equipment with the additional 'ground-out' feature, thereby giving complete, automatic and instantaneous protection against combustion explosions . . ."—E. Schneider, Director of Research and Eng'g, Wheelco Instrument Co.

1936. "L&N introduced the Thomas Type one-ohm standard resistor. Although the company had been producing N.B.S. standard resistors since 1914, this Thomas resistor made available the highest precision yet attained in a resistance standard . . . of the order of a few parts per million."—H. M. Parshall, Leeds & Northrup Co.

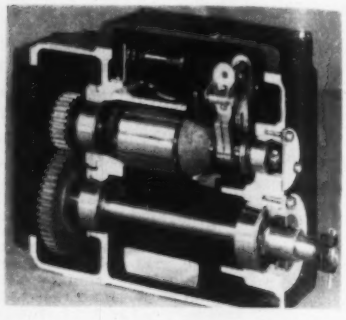
1936. "We brought out the Federal Low-Friction Full-Jeweled movement. The need for this was prompted by the fact that we noticed people were not supporting Indicators rigidly enough and in the interest of the greatest possible accuracy we should eliminate all the friction we could in a Dial Indicator. This proved to be one of our most successful forward steps."—I. A. Hunt, Federal Products Corp.



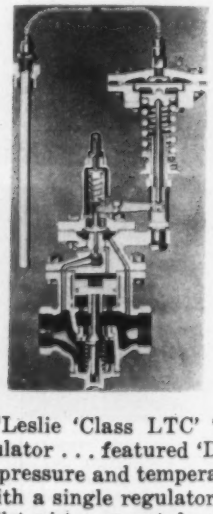
1936. "Twin 'Multimeter.' . . . made it possible for small laboratories to buy a single instrument which would be a portable 'Bureau of Standards' for accurate measurement of both alternating and direct current and voltage. . . ."—A. J. Lush, President, Rawson Electrical Instrument Co.

1936. "The Brown hair hygrometer was the first industrial recording hygrometer with this type of actuation . . . strands of carefully selected human hair, mechanical linkage . . .sensitive and accurate instrument with sufficient mechanical power to operate a recording pen. Also housed in the same case was a mercury actuated thermometer so that a permanent record of both dry bulb temperature and relative humidity is obtained."—C. C. Roberts, Brown Instrument Co.

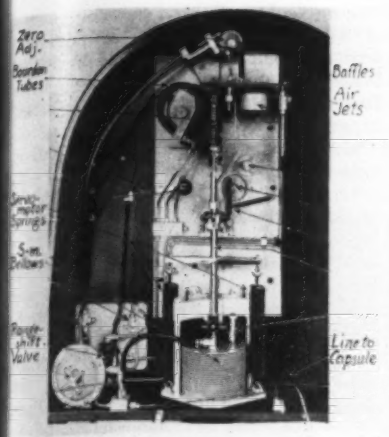
1936. "Micromax Electric Control, Position Adjusting Type, developed . . . the first to combine continuously proportional action with automatic droop correction . . . correcting automatically for both sudden and sustained changes in demand . . . Shortly after, the rate of droop correction was made variable, so that large changes were handled more rapidly than smaller ones."—H. M. Parshall, Leeds & Northrup Co.



1936. "'Model C' tachometer generator . . . embodied experience gained in tachometer manufacturing since 190[illegible] . . . many improvements designed particularly for speed recording applications on railroads, in steel mills [etc.] requiring rugged design . . . still being manufactured. Principal feature two internal shafts connected by gears. One carries armature and commutator; the other extends outside case for connection to machine . . . This design isolates armature from the driving machine and permits internal speed-changing gears . . . wide range of speeds . . ."—Don Brewer, Esterline-Angus Co.



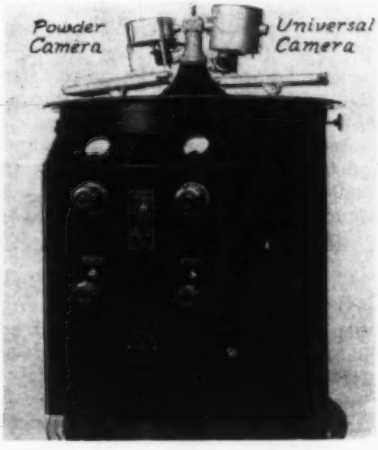
1936. "Leslie 'Class LTC' Temperature Regulator . . . featured 'Duo-Matic Control': pressure and temperature regulation with a single regulator utilizing internal-pilot piston-operated principle to eliminate the use of bellows or stuffing box . . . particularly unique because it accomplished both pressure and temperature regulation with a single pilot valve and anticipated a temperature change by responding to load changes indicated by a varying rate of steam condensation in the heat exchanger. The steam diaphragm feeling this change repositioned the valve to deliver more or less steam to the heater as the load varied and before a temperature change had affected the bulb which actually controls the pressure setting."—John S. Leslie, President, Leslie Co.



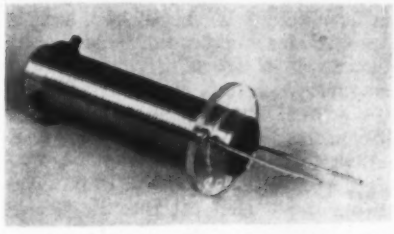
1936. "Baldwin-Tate-Emery Testing Machines were made much more useful by having the free end of the Bourdon tube effect control of an air-jet-baffle whose air pressure operates a pneumatic servomotor which restores the free end of the tube to a relatively constant position. The servomotor is powerful enough to operate the dial indicator as well as a recorder with a high degree of accuracy, sensitivity and response . . . essentially an automatic, pneumatically-operated force-balance . . . These improvements made testing machines much more useful because: (1) Operation on any load range greatly improved; (2) A large machine replaces several older machines of different capacities; (3) All accessory equipment . . . can be used in all ranges . . ."—M. G. Van Voorhis, for Baldwin Locomotive Works.

1936. Alternating-current Magnetic Comparator. "Designed by Sanford at the NBS primarily for testing tool-resisting prison bars in place, it has proved useful in many magnetic-analysis applications such as sorting materials, and comparing heat-treated steel products with standard specimens."—Hugh Odishaw, National Bureau of Standards.

1936. "Foxboro acquired the Atlantic Precision Instrument Co., Cambridge (and Malden), Mass., whose principal products were the Verigraph Weight Recorder and Verigraph Moisture-Content Recorder, in industrial use since 1926. These instruments, both especially adapted for the continuous measurement of variables in the production of sheeted materials, operated on what was then called the radio principle, and were actually the first industrial instruments in use employing the principles of electronics. Verigraph Instruments are still in extensive use, particularly in the rubber and paper industries."—Robert Barton, The Foxboro Co.



1936. Modern X-ray Diffraction Equipment. "Since 1927 I had gradually developed x-ray diffraction equipment . . . in 1936 we had all the above cameras developed with an x-ray diffraction power unit . . . voltage control in steps of 1 kv. from 0 to 60 and current control from 0 to 50 ma. . . . a far more elastic and useful diffraction apparatus. When I began . . . there was available only the old bulb-type heavy-walled x-ray tube . . . extremely long exposures (several days) before results could be obtained. This made industrial use almost prohibitive. . . . coöperation of the Machlett Labs . . . in developing highly-efficient tubes . . . Hays unit exposure times were reduced from days to minutes. The absolutely unique features, exclusive in the Hayes unit, is that by means of sideplates with tapered sleeves fastened on the head of the x-ray tube, we are able to suspend all our cameras directly from the tube, thus eliminating all tracks, minimizing distance from the focal spot and assuring reproducible alignment with the x-ray beam . . . Many new discoveries with extremely intense x-rays have already been made. . . . Until 1941 I was the only manufacturer of x-ray diffraction equipment."—J. Burton Hayes, Hayes Scientific Appliances.



1936. The Electric Hygrometer. "With the advent of the radiosonde [also 1936] a rapidly responding humidity-measuring device became necessary. All existing methods of measuring humidity were inadequate. The electric hygrometer was developed at the NBS to meet this need. It is standard equipment on radiosondes used by the government services . . . now finding application in many other fields, e.g. air conditioning . . . One form (illustrated) consists of a bifilar winding of gold or palladium wire on a polystyrene tube. The two bifilar windings are bridged with a water-pervious film containing a hygroscopic salt. The resistance of the film between the two windings varies according to the humidity. This resistance variation may be expressed in terms of the relative humidity."—Hugh Odishaw, National Bureau of Standards.

1936. The Radiosonde. "The radiosonde sends down from unmanned balloons information on upper-air pressure, temperature, and humidity. It was originally developed for the Navy Department by the NBS and has come into general use by the Navy, Army, Coast Guard, and Weather Bureau . . . It employs an ultra-high-frequency oscillator and a modulator. The frequency of the latter is controlled by resistors connected in the grid circuit. These resistors are special devices the electrical resistances of which vary with the phenomena. The modulation frequency is thus a measure of the phenomenon studied. Several phenomena may be measured successively, the corresponding resistors being switched into the circuit in sequence by switching unit driven by air pressure. This unit also serves for indicating the balloon altitude. At the receiving station on ground or shipboard a frequency recorder, connected in the receiving set output, provides an autographic chart of the variations of the phenomena with altitude. During the war this was the instrument which made possible more accurate weather forecasting, a factor of vital importance in military operations. Dr. Reichelderfer, Chief of the U .S. Weather Bureau, has declared that it took the advent of the radiosonde to make weather data significant."—Hugh Odishaw, National Bureau of Standards.

c. 1936. Magnetic Alloys. "Before the introduction of the 'Alnico' alloys, permanent-magnet materials were not powerful enough to provide more than stable magnetic fields . . . Prior to 1910 the only permanent-magnet material available was a carbon steel . . . Later chromium-steel or tungsten-steel alloys . . . In 1917 Honda added cobalt . . . about three times better . . . this was then produced by the G-E Research Laboratory . . . The discovery of precipitation hardening . . . Between 1928 and 1931 Kroll in France, Koster in Germany, and Dean in this country were experimenting with carbon-free alloys containing Be-Fe-Ni, Fe-W, and Fe-Mo . . . Many years previously the G-E Research Laboratory had developed a calorizing process . . . used the knowledge gained in this process to produce an Al-Ni alloy . . . 'Calite.' . . . magnetic properties were discovered. W. E. Ruder of G-E Research treated 'Calite' by the precipitation-hardening process and varied its composition to increase its magnetic properties. The result was an exceptionally fine permanent-magnet material. However . . . could not be made in diameters exceeding that of a lead pencil. The permanent-magnet materials now generally known as the 'Alnicos' are . . . variations of basic Al-Ni-Fe alloy system and have proved to be of greatest industrial impor-

tance. They vary in heat-treatment and composition to give property most desired such as coercive force, remanence, external energy or cost. . . . Now seven alloys . . . represent a range of coercive force of 400 to 950 oersteds, in residual induction from 6 to 12,000 gausses, and in maximum external energy from 1,400,000 to 6,000,000. . . . a revolution in the design of meters, instruments, [etc.] . . . 'Alnicos' are made by sand casting, precision casting, or sintering. They are hard, difficultly machinable . . . consequently are cast or pressed and finished by grinding. Although 'Alnicos' are the most powerful permanent-magnet materials available, . . . many applications require a malleable ductile permanent magnetic material or the ability to withstand extreme demagnetizing influences. To meet such requirements G-E produces such alloys as 'Cunife,' 'Cunico,' 'Silmanal' and 'Vectolite.' The first three . . . ductile, malleable . . . wide range of fabricating methods. 'Cunife' . . . can be drawn or cut to shape from wire which is so flexible that it can be formed in a coil or a spring. 'Cunico' can be made in strip and stamped . . . intricate shapes. 'Silmanal' . . . has the highest intrinsic coercive force of any permanent-magnet material . . . voltage regulators, polarity indicators [etc.] . . . 'Vectolite' . . . brittle, non-metallic lightweight material made from iron and cobalt oxides . . . rotor magnets . . . and other types of moving magnets."—A. M. Weinberg, Chemical Dep't (Pittsfield, Mass.) General Electric Co.

1937. "We brought out the 'Universal Testmaster Models 1 and 2.'"—I. A. Hunt, Federal Products Corp.

1937. "First Rotameter constructed with removable tube feature."—H. W. Gripton, Schutte & Koerting Co.

1937. "L&N introduced the Schering bridge for high-voltage testing of the power factor and dielectric constant of insulating materials."—H. M. Parshall Co., Leeds & Northrup Co.

1937. "Additional uses for 'Ranarex' were investigated by Permutit . . . special adaptations . . . for specific uses in the alloys and metals industry. Both stationary and portable models . . ."—K. F. Urquhart, for The Permutit Co.

1937. "The design and performance of Soxhlet Extraction Apparatus was investigated and new designs worked out. More efficient operation was obtained and useless complexities of shape eliminated. New and larger."—J. J. Moran, Kimble Glass.

1937. "Low-voltage Ohmmeters. . . . Typical was one . . . which would indicate as high as several megohms with only 4½ volts applied to circuit. Higher voltages would have damaged the circuits the customer desired to measure."—A. J. Lush, President, Rawson Electrical Instrument Co.

1937. "The first dead-beat gyro compass to be latter produced on a mass production basis . . . the Mark XIV Gyro Compass. Throughout World War II it was used extensively on the larger vessels of the Navy and merchant marine."—C. H. Jones, Sperry Gyroscope Co.

1937. "Baldwin's Bell Telephone Laboratories 2-16 ft.-lb. capacity Impact Machine, for Izod and Charpy tests, was an outstanding design development, especially in determining the general shapes of hammers and anvils . . . investigations including high-speed motion pictures . . ."—M. G. Van Voorhis, for Baldwin Locomotive Works.

1937. "The development by Brown of the non-bleed pilot valve provided a further improvement on pneumatic control systems by minimizing air consumption. The non-bleed construction permits the use of large supply and exhaust ports, thereby giving extremely fast control valve operation with a minimum of air wastage."—C. C. Roberts, Brown Instrument Co.

1937. "The DuMont 'Type 164' cathode-ray oscillograph . . . met with tremendous success and was sold in large quantities. . . . was a compact, portable instrument especially suitable for laboratory, shop, or field work. . . . In the same year, DuMont introduced the 'Type 168' Cathode-ray Oscillograph, . . . laboratory instrument . . . very high gain . . ."—J. H. Ruiter, Allen B. DuMont Laboratories.

1937. "The L&N Guarded Insulation Resistance Test Set was developed . . . the first direct-deflection, high-accuracy insulation testing equipment."—H. M. Parshall, Leeds & Northrup Co.

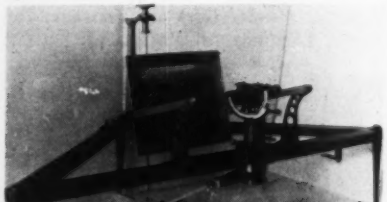
1937. "Concentric-magnet-type Electric Instruments . . . marked a radical change . . . consists of a soft-iron ring that completely encircled two sector-shaped Alnico magnets or pole pieces, between which are a moving coil and a magnetic core. . . . circuit is not only self-shielded, but is also magnetically self-contained. This construction was applied to medium-size portable ammeters and voltmeters."—R. Faille, Apparatus Dep't, General Electric Co.

1937. "Ashcroft was the first to introduce an Austenetic stainless steel Bourdon tube for services that would corrode ordinary stainless steels. Ashcroft introduced a new type of Manifold Pressure Gage for aircraft use which was an absolute pressure gage with the elements so sealed that the case itself carried no pressure. This reduced the fire hazard and increased safety . . . American introduced a new type of Dial Thermometer having a single-convolution Bourdon spring to provide greater resistance to vibration, such as encountered on high-speed locomotives."—S. Goodwin, Manning, Maxwell & Moore.

1937. "Single-phase Watthour Meter for all Domestic Loads (Type I-30). Rated 15 amperes, 240 volts, 60 cycles, this single-phase 3-wire watthour meter had an almost straight-line accuracy curve between the far-apart limits of 0.5 and 60 amperes. It was also little affected by changes in power factor, temperature, voltage, or frequency. . . . It is still today the standard G-E single-phase watthour meter." — R. Faille, Apparatus Dep't, General Electric Co.

1937. "Consolidated Engineering Corp. incorporated on March 1st by Herbert Hoover, Jr. and associates. This organization had functioned for the previous two years as the design and construction department for the parent United Geophysical Co. In June of that year the first Geophysical-type Recording Oscillograph was designed and built to give permanent photographic records of substrata data."— G. E. West, Consolidated Engineering Corp.

1937. "A direct-reading millivoltmeter pyrometer, the 'Limitrol,' with an automatic temperature shut-off device was introduced . . . designed to prevent temperatures rising above a pre-set danger point. It incorporated the Wheelco Electronic Control Principle. . . . It was the first direct-reading pyrometer with instantaneous automatic temperature cut-off and mechanical reset mechanism."—E. Schneider, Director of Research and Eng'g, Wheelco Instrument Co.

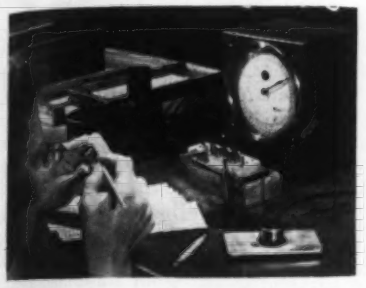


1937. "Photoalidade developed by the Geological Survey for determining elevation and position from oblique photographs." — W. E. Wrather, Director, Geological Survey, Dep't of the Interior.

1937. "New Method of Shielding Wires . . . 'Precision Coaxitube' . . . consisted of an insulated inner conductor and seamless outer sheath of copper, brass, nickel or aluminum. . . . perfect electrical shielding, . . . rugged mechanical and chemical protection, . . . thermocouple application, . . . precise coaxial cable for high-frequency transmission. . . . Its use in the instrument field has been broadened consistently . . ."—C. T. Flachbarth, Chief Engineer, The Precision Tube Co.

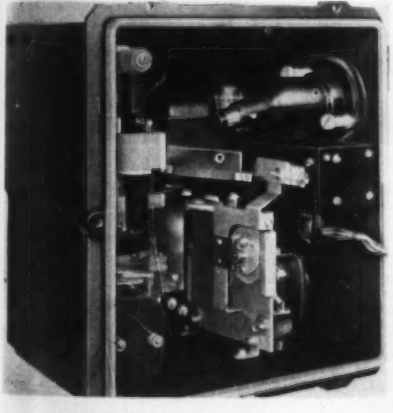
1937. "First precision-bore glass tubes manufactured in U.S.A. to 'machined tolerances' by giving interchangeability to 0.0002". . . . First precision-bore glass tubes of internal diameters 2" and larger and lengths

over 13" manufactured anywhere in the world. These tubes used principally in variable-area type flow-rate meters but also in viscosimeters, capillary-tube flowmeters, barometers, manometers, chemical machinery bearings, pump liners, [etc.] . . ."—Kermit Fischer, Fischer & Porter Co.



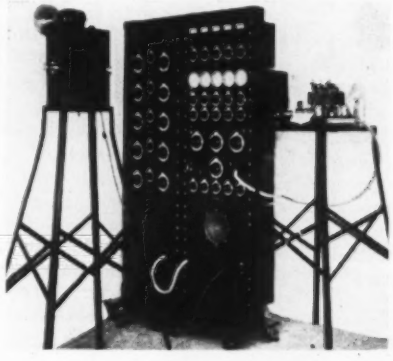
1937. "Our 'Time Microscope' developed by our Vice President George P. Luckey . . . the grand-daddy of all instruments since made to quickly ascertain the rate performance of timepieces . . . revolutionized factory techniques in bringing newly-assembled watches to time . . . It stroboscopically throws a beam of light on a pulsating balance wheel (see photograph) and then, with an adjusting dial, the synchronous motor activating the light is speeded or retarded until the balance wheel appears to be stationary. The dial reading then indicates how many seconds fast or slow the watch containing the balance wheel will run in 24 hours." — R. Waddell, Hamilton Watch Co.

"1937 saw the development of the Brown 'Analy-Graph' . . . operated on fundamentally the same principle as the older (1924) Brown CO_2 meter . . . more versatile and more sensitive. By using a potentiometer type of instrument of both oxidizing and reducing greatly improved. This, combined with minor changes in the old cell circuit, plus a-c. operation, permitted measurement, the sensitivity of the device was atmospheres. Thus, the 'Analy-Graph' was the first universal device successfully used . . ."—C. C. Roberts, Brown Instrument Co.



1937. "TAG brought out the 'Celectray' Indicating Potentiometer Controller for throttling electric and fuel heat. This was the first electronic controller to employ the Gouy method of proportioning the ratio of 'time-on' to 'time-off' of power to electric furnaces."—George Terhune, C. J. Tagliabue Mfg. Co.

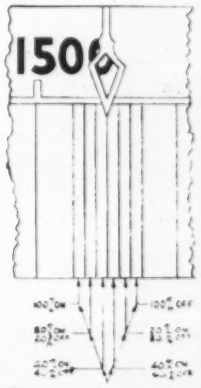
1937. Inception of Radar. "July 13th Bell System engineers conferred with Dr. A. H. Taylor of the Naval Research Laboratory at Anacostia, at which time he and his staff demonstrated the progress they had made in secret experimentation with the use of radio waves for detection and ranging for the purpose of object location. Thereafter until the end of World War II, Bell System engineers contributed importantly to the major developments in the field of radar and Western Electric manufactured more than half the dollar volume of radar equipment purchased by the Government during World War II."—F. H. Lovette, Historian, Western Electric Co.



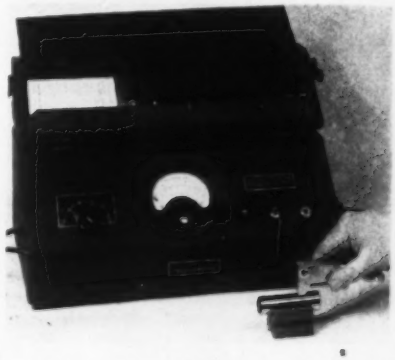
1937. ". . . advanced further with the design of the electroencephalograph, and produced portable and stationary equipment with single and multiple channels [five-channel illustrated] . . . Because of extreme sensitivity required, earlier stages of equipment were still battery operated." — Lovett Garceau, Electro-Medical Laboratory, Inc.

1937. "D-c. Selsyn Aircraft Instruments. The d-c. Selsyn system, developed by G-E, is a simple means whereby movements, detected by the transmitter, are sent by electromagnetic means to an indicator on the instrument panel . . . The system was not an immediate success; to just a few engineers goes the credit for persistent efforts in developing the system and advancing its acceptance in the aviation industry. G-E built most of the position-indicating instruments used on U.S. aircraft. . . . during the war supplied approximately 40% of the liquid-level-indicating equipment. Later, . . . other types of remote-indicating equipment, . . . six different forms were developed."—R. Faille, Apparatus Dep't, General Electric Co.

1937. "The Chrono-tachometer . . . result of the precision timer (1931) and its improvements since that date; fulfills SAE specification for testing internal combustion engines: "Speed measurements shall be made by counting the revolutions of an engine for a period of one minute" with a thoroughly reliable, accurate and rugged instrument. . . . It consists of the following: (1) A high-grade electric indicating tachometer with 6" dial and a scale length of approx. 66" which permits very close reading. . . . accuracy of ±10 rpm. in the lower ranges, ±100 rpm. in the 40,000 range; (2) A revolution counter, for 0-3500 tachometer range counter range is 0-6000 before repeating, with smallest graduation of 1/5 revolution; for other tachometer ranges counter range is 0-30,000, smallest division 1 rev. (3) A 'Model S-6' precision timer, accuracy of 1/1000 minute per test run. The Chrono-tachometer instrument is furnished with a generator . . . for attaching to shaft of prime mover . . . generator drives indicating tachometer and revolution counter. By means of the control switches a test run of 1/10 minute or any multiple thereof may be automatically made. . . . about 95% of all aircraft engines made in the U. S. are tested with this instrument."—H. P. Blake, Standard Electric Time Co.



1937. "The Wheelco 'Proportioning Capacitrol' was designed for use where a continuously-changing input to the load is required to maintain constant temperature without overshooting or undershooting. A synchronous motor driving an offset cam was added to the basic Wheelco Electronic Control Circuit [see 1935] and mounted so that the cam can pass through the field of the oscillator plate-tank coil. The proportioning band can be changed by adjusting the eccentricity of the cam on its shaft. The cam has no effect upon the operation of the circuit until the control vane enters the proportioning band. Then the position of the vane within the proportioning band determines the ratio of ON to OFF time and hence the percentage of fuel input." — E. Schneider, Director of Research and Engineering, Wheelco Instruments Co.



1937. The Profilometer. "For nearly a century, drawings have shown specifications of 'finished' surfaces. The old 'f' mark showed that size and finish of the indicated surface were important. . . . 'Finish' remained a matter of human judgment with 'eye and fingernail' observations. Numerical specifications were severely needed. . . . The Profilometer was the pioneer instrument for surface roughness measurement and currently dominates the field. The fundamental concept was the rapid measurement of some hundreds of individual surface irregularities, combined with an instrumental computation of average height measured from a center line, and followed by a simultaneous meter

measurement of this average. This average is expressed directly in microinches. The measurement is obtained by means of a sharp, ball-pointed tracer point, whose movements are measured electrically, and amplified to drive an indicator. The Profilometer has been developed into a line of items providing adaptability to almost any surface which can be machined or ground. . . . The changes and savings in machining and grinding operations which have resulted from bringing surface roughness under engineering and measurement have been very impressive."—Ernest J. Abbott, Physicists Research Co.

1937. "DuMont introduced the 'Resonoscope' . . . special cathode-ray oscillograph and a standard set of tuning forks which covered the frequencies of the twelve notes of the chromatic musical scale. . . . checking the musical pitch of instruments and vocalists alike. . . . The frequencies produced by the twelve electrically-driven tuning forks were used to synchronize an oscillator in step with them. The oscillator then provided the horizontal sweep circuit of the cathode-ray tube. A dynamic microphone picked up the sound under investigation, fed it to an amplifier whence it was applied as a voltage to the vertical deflection plates of the c-r. tube. If the note were of the same pitch (or frequency) as the predetermined standard, or any harmonic of it, the image on the screen appeared to stand still. If the pitch were different, the image moved to either right or left."—J. H. Ruiter, Allen B. DuMont Laboratories.

1938. "Standard interchangeable Rotameter rotor made."—H. W. Gripton, Schutte & Koerting Co.

1938. "A. R. L. equipment was augmented by accessories produced by the Harry W. Dietert Co."—Gwen Barkelew, Applied Research Laboratories.

1938. ". . . small spur-gear reducer motor designed to meet the needs of advanced instrument designs . . . smallest motor of its kind delivering enough power to meet most instrument needs." —W. M. Yogerst, Bodine Electric Co.

1938. The Absolute Altimeter. "Western Electric demonstrated the first terrain clearance indicator, or absolute altimeter, through which a radio echo indicated the altitude of an airplane." — F. H. Lovette, Historian, Western Electric Co.

1938. "Ashcroft Gages and American Dial Thermometers were first to introduce the phenolic turret case which combined lightness, corrosion resistance and improved strength over previous types."—S. Goodwin, Manning, Maxwell & Moore.

1938. "By this time we had added to our line of Indicators so that we could furnish practically any graduation, any range, five sizes of Indicators, our Testmasters, Perpendicular Indicators; broadest line of Indicators offered by any manufacturer."— I. A. Hunt, Federal Products Corp.

1938. "Introduction of 'R.M.B. Miniature Ball Bearings' in this country . . . a comprehensive line of unusually small ball bearings. . . . has large number of industries, but their chief applications are still, today, in instruments of all kinds. . . . over 200 types and sizes from 0.043" . . ."—M. Wiesendanger, Landis & Gyr, Inc.

1938. "Leslie 'Class D' Diaphragm Regulating Valve featuring single-seated balanced construction combined balance of double-seated valves and tight closing of single-seated valves . . . full seat areas provided capacities equal to or greater than conventional double-seated construction."—John S. Leslie, President, Leslie Co.

1938. "Development and production of our 'Vibrotest' line . . . Previously, the only source of self-contained portable insulation resistance testing instruments was by means of importation . . . necessity for an instrument capable of measuring insulation resistance under any and all conditions manufactured in the U. S." — J. F. Inman, Associated Research, Inc.

1938. "The 'Flame-Eye' broadened the applicability of the 'Flame-otrol' as a safety device, . . . for use with oil-fed combustion equipment. Instead of employing the principle of flame conductivity, the 'Flame-Eye' utilized a sensitive photocell actuated by the radiation from the flame."—E. Schneider, Director of Research and Eng'g, Wheelco Instrument Co.

1938. Micropotentiometer. "The development of novel methods of reducing or eliminating parasitic emf's at the NBS led to the design of a potentiometer for measuring voltages of the order of 10 μv. (parasitics less than 0.002 μv.). Potentiometers embodying these methods are now commercially available."—Hugh Odishaw, National Bureau of Standards.

1938. "The Fisher 'Level-Trol' represented an entirely new conception of level control, . . . the first application of the displacement member suspended by resilient means to measure liquid level, with high degree of sensitivity and minimum friction in measuring element. It also introduced means of obtaining long-range level control by means of a float-actuated controller." — J. J. Mullen, Fisher Governor Co.

1938. "Foxboro introduced the Temperature-Pressure Relation Controller for measuring and controlling the purity of product. This was originally used on digester relief control, to relieve the accumulated air mixed with steam. It has since been adapted to other applications where the relation of actual pressure to the vapor pressure of a fluid of known purity, at the same temperature, provides a measure and control basis." — Robert Barton, The Foxboro Co.

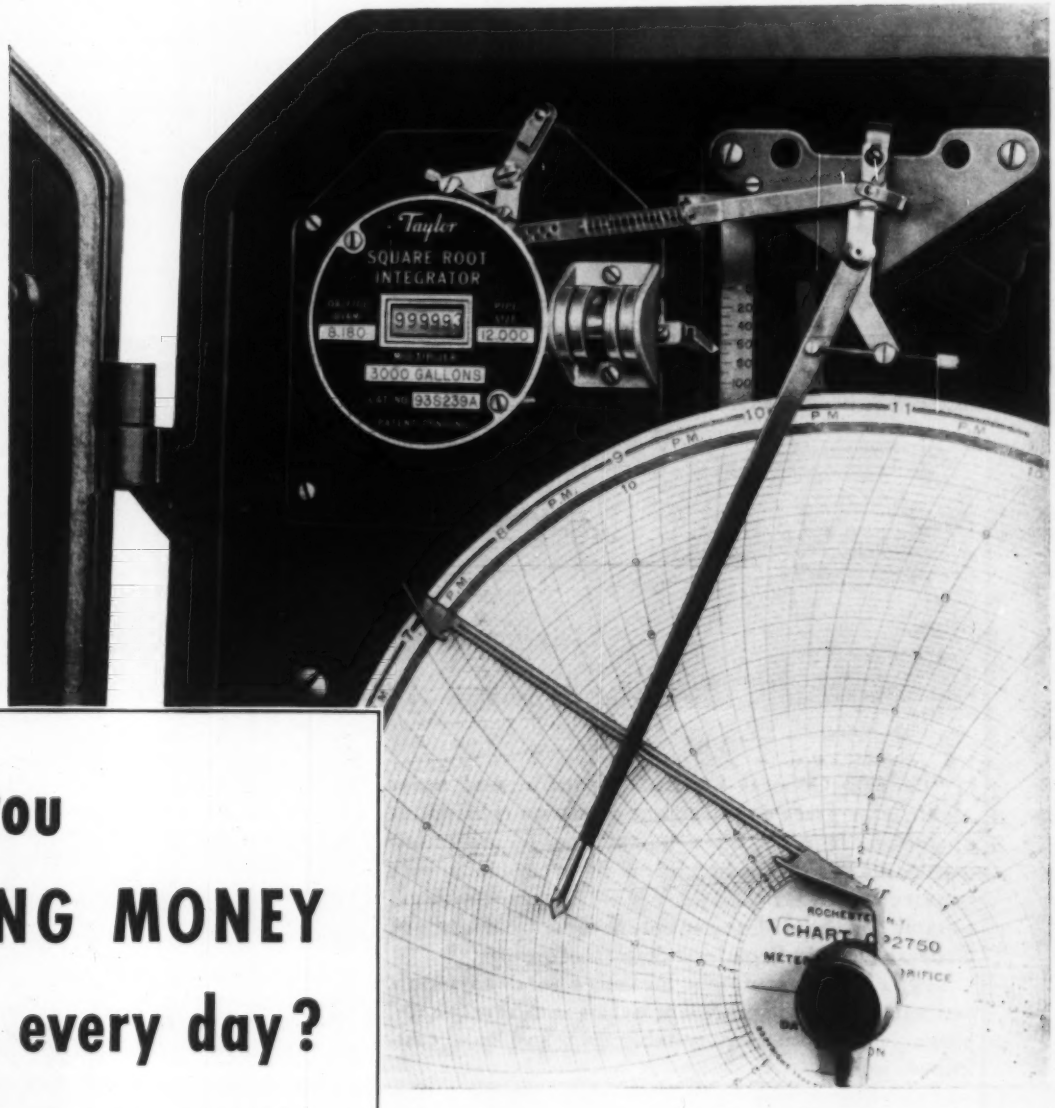
1938. "For many years it was thought impossible to control automatically the temperature and moisture or steam admittance to batch or stack type cottonseed cookers. In 1938 TAG developed . . . for a large chain of cotton mills in Texas, a successful system . . . consisted in coördinating temperature recorder-controllers, Duplex Temperature - Moisture Recorder - Controllers, diaphragm valves, calibrated condensation chamber, steam traps, air filter and air reducing valve."—George Terhune, C. J. Tagliabue Mfg. Co.

1938. ". . . a new type of potentiometer known as the Bristol 'Pyromaster.' This instrument was built first as a pyrometer in indicating, recording, and automatic-controlling models, and was one of the first of the potentiometers having an operating mechanism that did not run continuously . . . unaffected by vibrations . . . operating mechanism required no lubrication; galvanometer enclosed in a gasketed case protecting it from dust and air currents when door of instrument is opened . . ."—G. P. Lonergan, The Bristol Co.

1938. "Leslie 'Type PR' and 'PD' Control Pilots for use with air, gas, clean water or light oil as the operating medium . . . provided instrument control at minimum operating and maintenance expense . . . double-acting pilot valve permitting accurate dependable control without continuous leak-off, without a stuffing box and without the use of a Bourdon tube."—John S. Leslie, President, Leslie Co.

1938. End Standards. ". . . to provide end standards of the highest precision, the NBS constructed a series of end standards of fused quartz by direct interference methods, based upon the standard wavelength of the red line of cadmium. Illustration shows these fused quartz end standards, probably the most accurate standards of length in the world. (Not shown: interference comparator for testing the parallelism of the two end surfaces of the end standards; comparator for testing the flatness and accuracy of the length of the end standards.)"—Hugh Odishaw, National Bureau of Standards.

1938. "Combination of the comparator and densitometer in one instrument . . . made possible measurement of transmission of a particular spectral line as it was projected on the screen new development found acceptance in industry as a means of achieving greater speed and accuracy in the precise



Are you LOSING MONEY every day?

IT may be costing you plenty not to have an accurate check on the efficiency of your major processing units. And that's what the new Taylor Integrating Flowmeters (Aneroid or Mercury) can do for you. Automatic totalizing provides you with an accurate comparison of fluid through-put to yield of finished product. In addition, these dependable instruments give accurate cost data on departmental steam consumption for heating and processing. And they detect any abnormally high steam consumption caused by faulty operation of traps or valves.

First the manometer precisely measures the rate of flow. Then the Taylor Square Root Integrator accurately totalizes the flow of liquids, and of gases and steam under constant pressure. The Integrator is easy to read through a large (2-inch) window in the case door. Dependable, synchronous motor drives counter through positive clutch without the use of ratchets. Continuous check on accuracy of calibration at any point of range. Both Oilite and ball bearings for long life. Few moving parts; permanently lubricated cam rollers, self-lubricated bushings; positive, oil-proof counter clutch.

For full details, ask your Taylor Field Engineer. Also ask him about the new Taylor Aneroid (mercury-less) Manometer, with no mercury, no pivots, no stuffing box! Write for Catalog 98175. Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.*

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New DISTORTION AND NOISE ANALYZER

TYPE YDA-1

THIS new General Electric distortion and noise analyzer gives a convenient check on transmitter operation. It provides a quick, visible indication that your station is operating in accordance with required standards. The YDA-1 is also entirely suitable for use with the widely accepted FM and AM General Electric Broadcast Station Monitors.

The YDA-1 accurately measures total harmonic distortion and noise present on an audio frequency, particularly that present in laboratory and broadcasting equipment.

The unit may also be used as a sensitive voltmeter. Its sensitivity is of special advantage in measuring low level audio signals.

DISTORTION MEASUREMENTS:

Distortion range:	1, 3, 10, 30 and 100% full scale
Frequency range:	50 to 15,000 cycles per second in 5 ranges
Accuracy:	5% of full scale plus 1/10% distortion

NOISE MEASUREMENTS:

Noise range:	+2 to -80 db referred to 1 milliwatt on 600 ohms
Frequency range:	30 to 30,000 cycles per second
Accuracy:	5% of full scale

VOLTAGE MEASUREMENTS:

Vacuum tube voltmeter for general purpose measurements. Dial is calibrated from +2 to -80 db referred to 1 milliwatt on 600 ohms.

For complete information on the YDA-1, and other precision equipments write: *General Electric Company, Electronics Department, Electronics Park, Syracuse, New York.*

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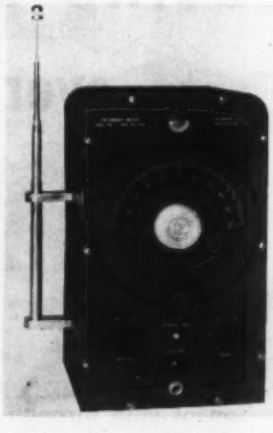
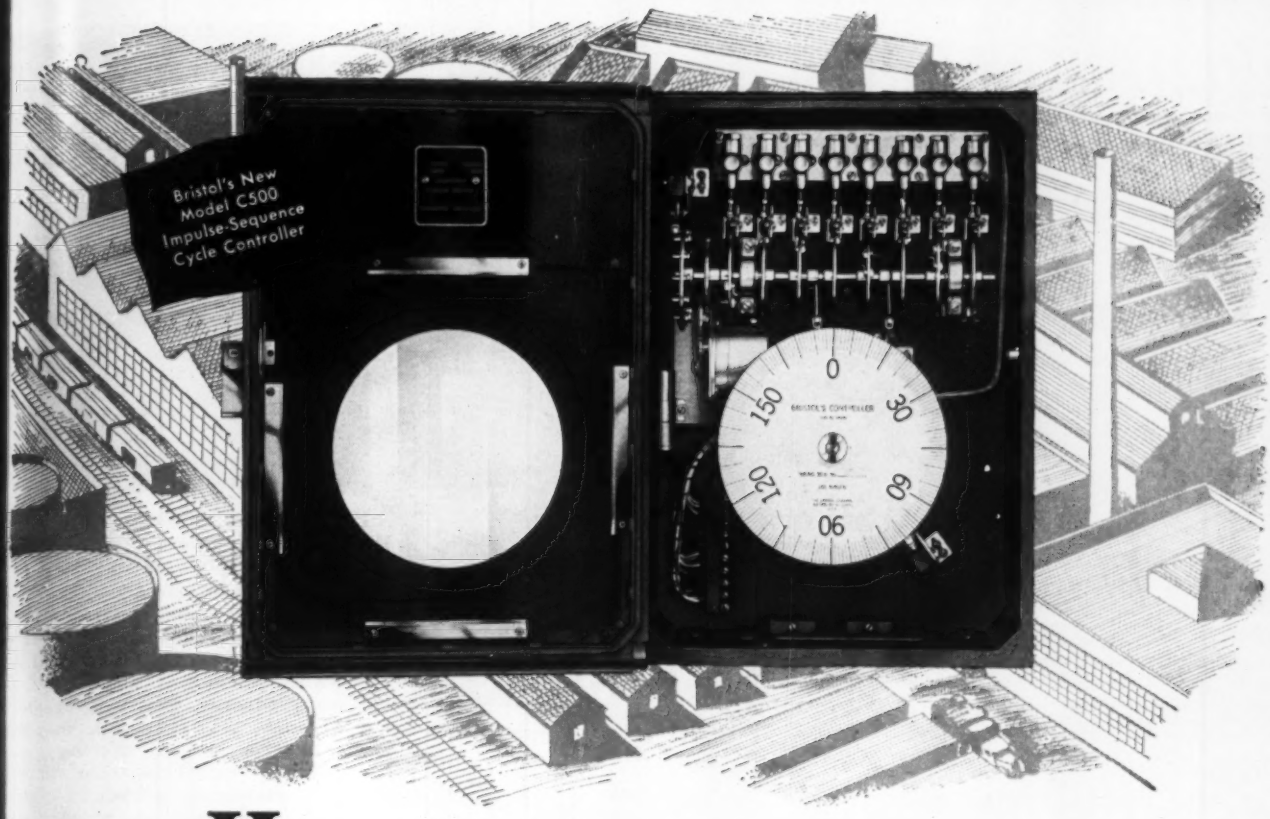
quantitative analysis of all types of samples. . . . A still newer development . . . use of a densitometer slit testing on the film to be measured . . . improved accuracy . . . eliminated scattered light . . . first use of this principle in densitometry."—Gwen Barkelew, Applied Research Laboratories.

1938. "Under the direction of Dr. Harold W. Washburn, the first experimental model of a commercial Mass Spectrometer was designed and built. (Illustrated) . . . originally applied to soil-gas analysis, . . . field of use was expanded to analysis of complex gas and light mixtures, for which it is now used universally."—G. E. West, Consolidated Engineering Corp.



1938. "Browning 'Model S-1' Frequency Meter for police, [etc.] . . . was the first of its type . . . only a narrow range of frequencies on each band with customer's specified frequency near middle of band. Each meter custom-built and individually calibrated . . . accuracy better than 0.01%. . . ."—G. H. Browning, Browning Laboratories.

1938. "The first Brown pneumatic transmitters were introduced . . . a simple, accurate, and safe way to transmit temperature, pressure, flow, or liquid level measurements from a hazardous point to a remote instrument. Transmitter operates by proportioning an air pressure change in direct relation to any change in the variable under measurement by means of



Here's Good News for Process Industries!

. . . Bristol's New, Improved Model C500 Impulse-Sequence Cycle Controller Gives Closer Quality Control . . . Improved Product Uniformity . . . Lower Processing Costs — Through BETTER TIMING.

Bristol's new precision timing instrument contains many features that make it ideal for controlling cycle processing:

EXTREME TIMING ACCURACY . . . timing mechanism and pilot valve mechanism are separately powered, electrically coordinated . . . *timing mechanism does no work.* 25" time scale gives highly accurate timing.

EASE OF CYCLE SET-UP . . . time intervals are set by notching a rigid aluminum disc. Cams that actuate pilot valves are adjustable quickly, accurately, simply . . . *no fine adjustments or cam cutting needed.*

FLEXIBILITY . . . controller can be quickly changed from one cycle to another by replacing timing disc and adjusting cams. *One controller may serve any number of operating schedules* by providing a properly notched disc for each. Controller can be arranged for 1 to 8 cams and pilot valves.

POSITIVE ACTION . . . motor supplies high torque to operate pilot valves instantaneously . . . *pilot valve operation is accomplished by direct cam action without gear shifts, clutches or relays.*

AUTOMATIC RESET . . . after completion of the cycle, controller is automatically reset to the starting position *by positive motor drive.*

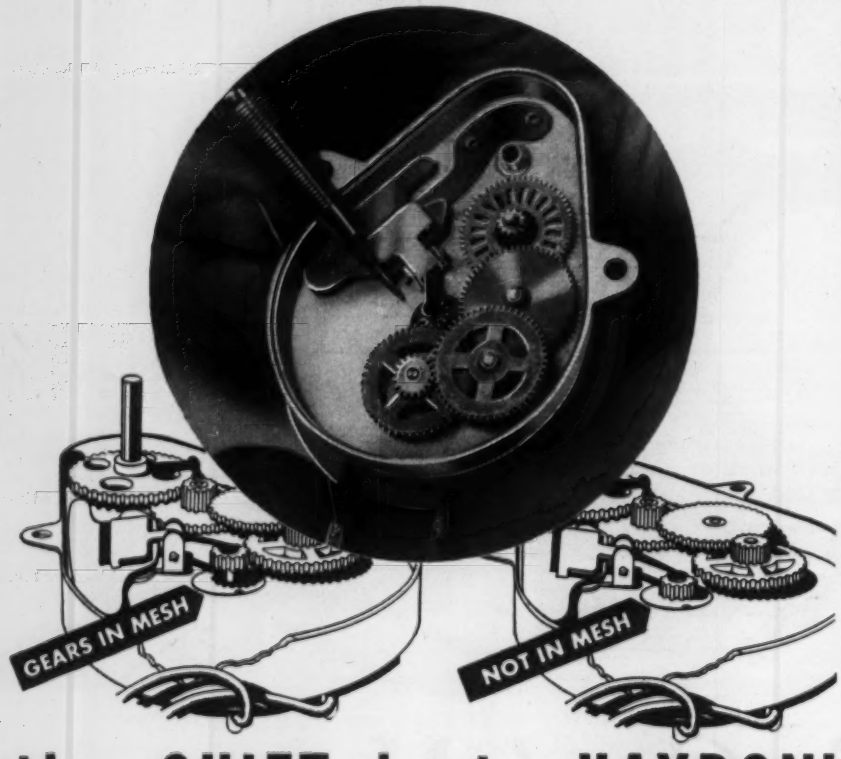
Bristol engineers will gladly show you how this remarkable new instrument will not only pay for itself . . . but will pay *you* profits year after year in service. There's no obligation of course. Write: The Bristol Company, 113 Bristol Rd., Waterbury 91, Conn.

BRISTOL

Engineers process control for better products and profits

AUTOMATIC CONTROLLING AND RECORDING INSTRUMENTS

For Automatic Reset Timing



the SHIFT is to HAYDON!

An automatic shift mechanism has been built into the Haydon 1600 series synchronous motor and gear unit by Haydon engineers, making possible immediate automatic resetting for devices such as time delay relays, process timers, interval timers, etc. The magnetic pull of the energized motor field is utilized to engage the gear train while the timing operation is in progress. A counterbalance in the shift disengages the gear train from the motor when the motor field is de-energized. The drive shaft is then free to be reset to its starting position by means of an external spring. Engaging and disengaging action is uniform in any position.

- **Available in speeds from 15 to 1/10 rpm.**
- **Information on this exclusive shift feature, and complete data on all Haydon synchronous motors and timers, is available in the new 1948 Engineering Catalog.**
- **If it's about time, request a demonstration of Haydon products at *your* desk.**

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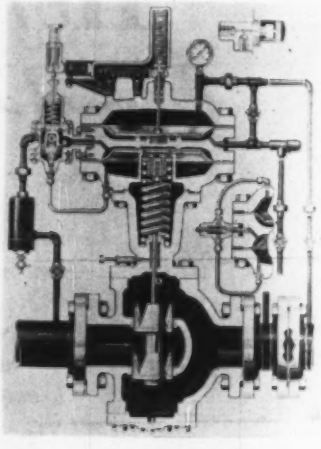
HARNESS TIME TO YOUR PRODUCTS

SUBSIDIARY OF GENERAL TIME INSTRUMENTS CORPORATION

a flapper and nozzle system . . . Receiver is basically a recording pressure gage . . . The use of matched bellows in transmitter and receiver results in precise transmission and ease of calibration."— C. C. Roberts, Brown Instrument Co.

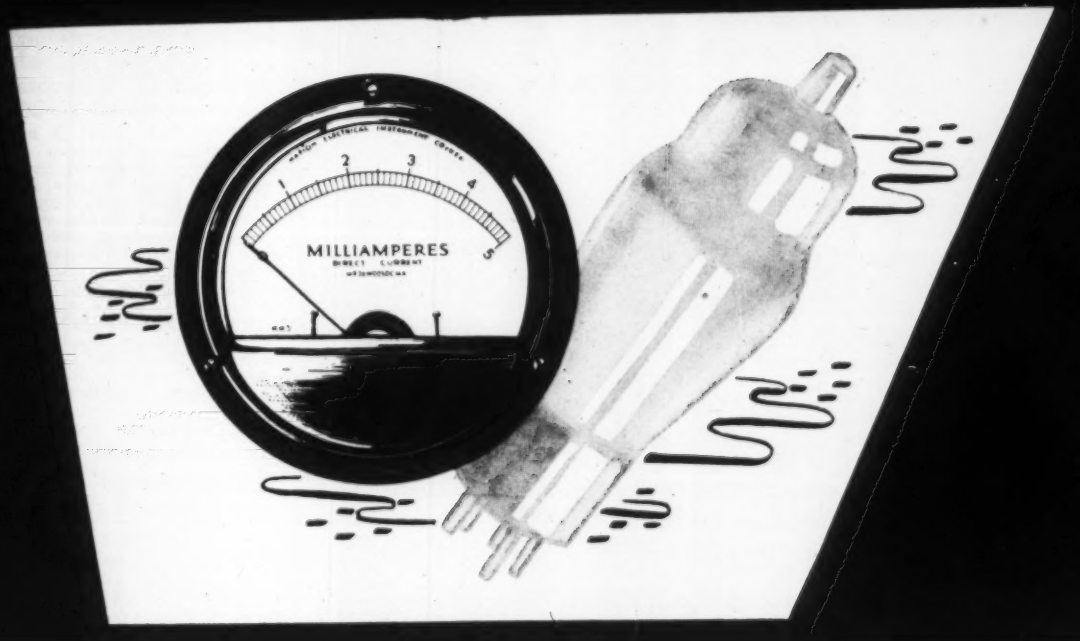
1938. "The 'Monitor' Predetermined Electric Counters were introduced. Outstanding improvements included (1) Quick selection or change of predetermined number setting by panel-mounted dials; (2) Automatic reset making possible automatic batch counting of continuous production without interrupting production and without missing a count; . . . (4) Built-in automatic electric controls offering great flexibility in count-controlling conveyors, . . . packaging mechanisms, etc.; (5) Operating speeds up to 600 counts per minute; . . ."—R. H. Allbright, for Production Instrument Co.



1938. "Fisher 'King Booster' . . . increase automatically the downstream or reduced pressure in a gas distribution system to correspond to and counteract exactly the pressure drop caused by friction in the downstream or reduced pressure piping system . . . constant pressure at the low pressure point in the distribution system, regardless of demand load."—J. J. Mullen, Fisher Governor Co.

1938. "Flexure Plate Mounting for Telescope or Collimator. The NBS developed this mounting which, by application of flexure plates, permits a telescope or collimator to be raised or lowered while remaining parallel to itself and to be rotated through small angles about a horizontal and vertical axis. . . . When an adjustment is made,

In Step with Electronic Progress . . .
Modern Hermetically Sealed Instruments



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Progressive manufacturers of electronic equipment declare an hermetic seal is as important in a meter as it is in any other product component. That's because meters are just as susceptible to the harmful effects of dust, moisture, corrosive fumes and other destructive factors as resistors, capacitors or transformers.

Therefore, hermetically sealed meters are a "must" in achieving top product performance.

MARION HERMETICS ARE NOT PREMIUM PRICED

Marion glass-to-metal hermetically sealed meters offer you the accuracy, superiority and extended life of an hermetically *sealed* component at a price no higher than most competitive *unsealed* instruments. All Marion hermetically sealed instruments are 100% GUARANTEED.

LOOK AT THE FEATURES OF MARION "HERMETICS"

DURABLE

. . . Unaffected by extremes of heat or cold . . . permanently protected against dust, dirt, moisture . . . instrument malfunctioning minimized.

SHIELDED

. . . Heavy steel case gives magnetic and electrostatic shielding so important in modern high frequency equipment.

INTER-CHANGEABLE

. . . The Marion case, with its high conductivity plating, eliminates the need for separate shielding and permits interchangeability on any type panel without affecting calibration.

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Interchangeable Round and Square Colored Flanges . . . one instrument can thus fill four different needs:

1. Round
2. Round for Steel Panel
3. Rectangular
4. Rectangular for Steel Panel

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THE NAME "MARION" MEANS THE "MOST" IN METERS

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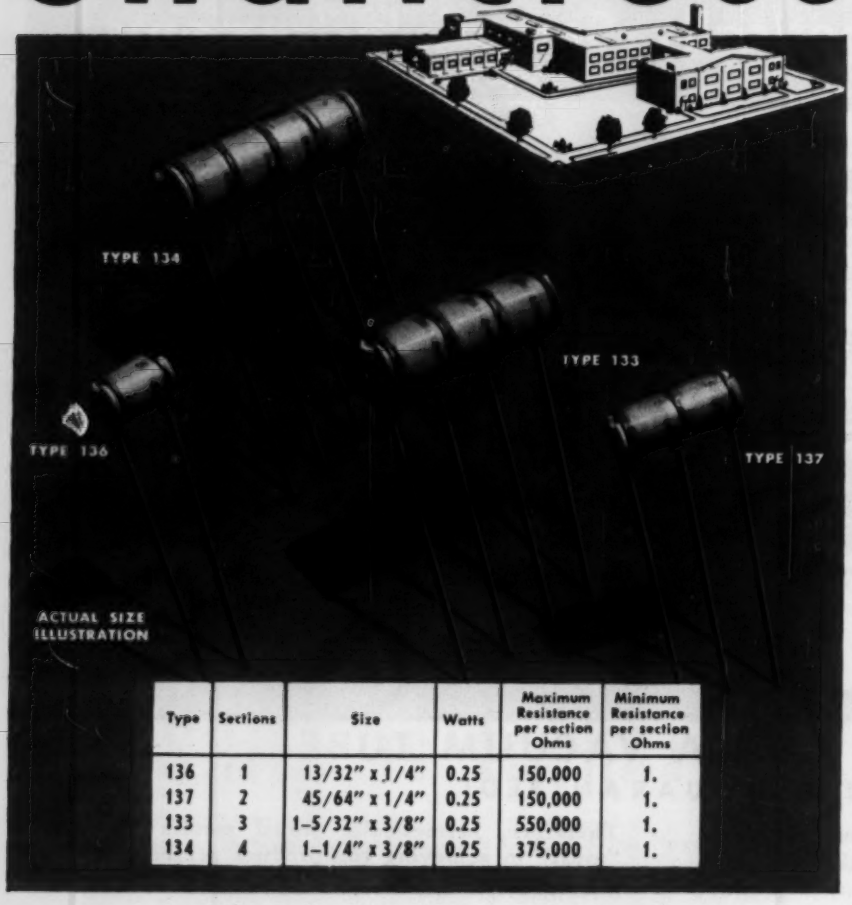

Type	Sections	Size	Watts	Maximum Resistance per section Ohms	Minimum Resistance per section Ohms
136	1	13/32" x 1/4"	0.25	150,000	1.
137	2	45/64" x 1/4"	0.25	150,000	1.
133	3	1-5/32" x 3/8"	0.25	550,000	1.
134	4	1-1/4" x 3/8"	0.25	375,000	1.

AKRA-OHM PRECISION RESISTORS

for "miniaturization" programs

These new Shallcross Akra-Ohm Wire-Wound Precision Resistors have been designed to meet the needs of modern, miniature equipment. Standard tolerance is 1% and closer tolerances can be furnished on special order.

The units offer unusually high and accurate resistance values in small space and are light enough to be suspended by their own tinned copper leads, or may be secured with mounting screw.

Other Shallcross Akra-Ohm Precision Resistors include types, shapes, mounting arrangements and ratings for every close-tolerance requirement and are designed to meet JAN specifications. Write for Bulletin RG, giving complete precision resistor data in convenient chart form.

Complete Service measurement facilities
IN A SINGLE INSTRUMENT

The improved Shallcross 614-A Service meter covers a wide range of measurements. These include d-c and a-c voltage, capacitance, and d-c resistance. Also it can be used for approximating an artificial load. Auxiliary scales provide an inductance range of 1 to 100; 1,000, 10,000 henries, and an a-c resistance range of 25 ohms to 3 megohms. Only two switches are used for 25 ranges. The instrument is self-contained, housed in a metal case with handle and weighs only 12½ lbs. Write for details.

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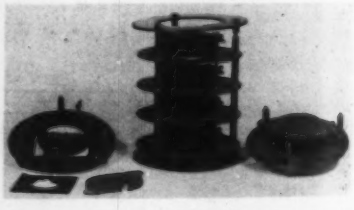
the setting is maintained without the use of a clamp—a great advantage for many users. . . . The advantages . . . simplicity and cheapness of construction, smoothness of movement, freedom from clamps, and freedom from lost motion. . . ."—Hugh Odishaw, National Bureau of Standards.

1938. "The 'Remotomike' was perfected . . . A remote-reading inside micrometer . . . unique principle . . . internal diameters of long tubes for which no instrument was previously available. Primary measurement is mechanical—three ball trains, arranged radially in a housing, determine longitudinal position of a measuring cone free to move laterally within inner ball circle (concentric alignment unnecessary). Longitudinal position of primary measuring cone transmitted to receiver by means of a patented electrical impedance bridge; magnification accomplished by taper of cone—as much as 24 to 1—further amplified electronically usually 25 to 1 (may be 62.5 to 1) . . . overall amplification as much as 1800 to 1. Even before the war . . . 'Remotomike' in use on every continent in the world. . . ."—F. M. Poole, President, Poole Instruments, Inc.

1938. "Gas Regulators . . . an atmospheric regulator which would give a constant downstream pressure regardless of variations in the upstream gas pressure . . . a balancing diaphragm neutralized the pressure on the valve head so that the gas diaphragm which did the regulating would be free to operate without being affected by the varying upstream gas pressure. . . ."—H. L. Jenkins, North American Mfg. Co.



1938. Surface Abrasion Test for Porcelain Enamels. " . . . essentially measuring the reduction in gloss of enameled specimens produced by a standard abrasion treatment. A test method based on this principle was developed at the NBS and adopted as a tentative standard of the Porcelain Enamel Institute in 1938. (In 1942 it was made a standard of the

NEW! NEW!

PRINCO "EASY-SETTING" DIAL THERMOMETERS

5 Standard Scale Ranges
Fahrenheit or Centigrade

●

"Easy-Access" Cases
for Quick Setting

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Simplified Dial
and Pointer Adjustment

●

Rugged, Accurate,
Bimetallic Unit.

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PRINCO "*Easy-Setting*" SPECIFICATIONS:

Type — Positive, bimetallic-actuated industrial, back-connected.

Case — Cast aluminum, available in moisture-proof or "Quick-Opening" threaded frame construction.

Frame — Polished aluminum.

Pointer — Special vibration-damping construction.

Dial — 4" diameter, black figures, silver ground.

Stem — Standard lengths — 4", 6", 9", 12"; ¼" diameter, stainless steel; separable sockets available.

Connection Nut — ½" male S.P.T., brass.

Immersion — 3" (minimum).

Ranges — 5 standard, Fahrenheit or equivalent Centigrade (covering — 100° to +850° F. or — 75° to +450° C.)

Accuracy — 1% of range (at any point of indication).

Write for prices and additional information.

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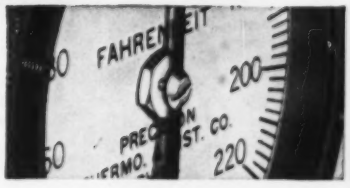
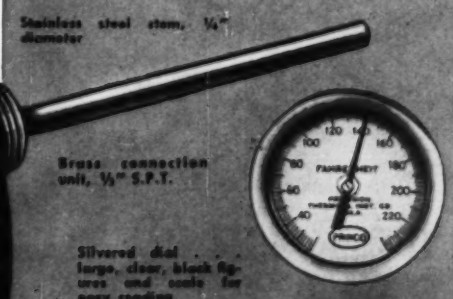
"EASY-SETTING" POINTER & DIAL



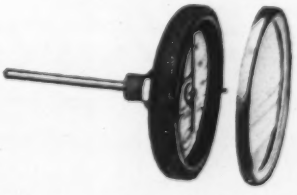
To set POINTER hold slotted hub with screwdriver and move pointer.
To set DIAL loosen hex nut and rotate dial.
ALL ADJUSTMENTS EASILY MADE "ON THE JOB."


Stainless steel stem, ¼" diameter
Brass connection unit, ½" S.P.T.
Silvered dial . . . large, clear, black figures and scale for easy reading

TWO "EASY-ACCESS" CASE TYPES

Readily detachable frames permit all adjustments to be made from the front, without removal of thermometer from service.

"QUICK-OPENING" TYPE CASE—the only dial thermometer with a *threaded frame* . . . easily and quickly unscrewed with the fingers.



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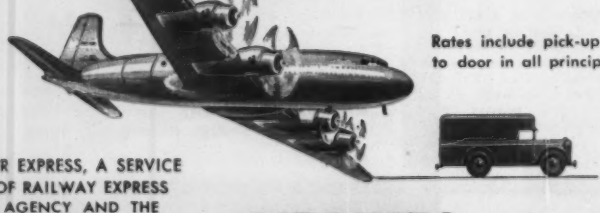

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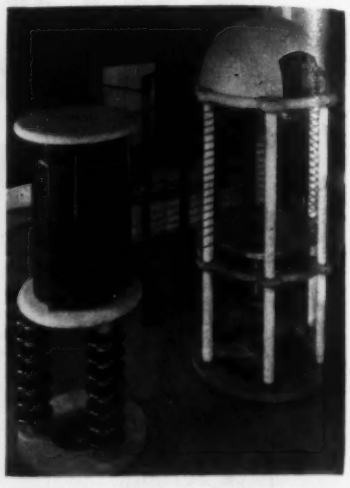
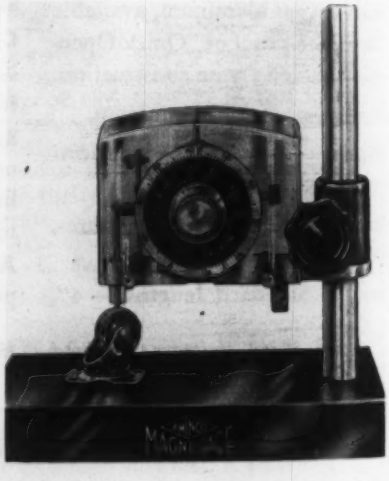
Institute). The abrasion treatment is produced by oscillating a mixture of [illegible]inless steel balls, feldspar and water on the specimen for a definite time under closely controlled conditions . . . uniform abrasion on the surface of the specimens which are naturally slightly wavy in an 'orange peel' pattern, thus avoiding scrubbing off the tops while leaving the depressions unaffected . . . —Hugh Odishaw, National Bureau of Standards.



1938. The Brooks Absolute Electrometer. "This modification by the NBS of the Kelvin guard-ring type of electrometer was designed for use on alternating voltage to 275 kv. The introduction of guard hoops equally spaced both mechanically and in voltage (by means of a voltage-dividing capacitor) between the high voltage guarded disk and grounded lower plate, coupled with refinements in construction of components, make this electrometer suitable for absolute measurements . . . A long program of intercomparisons at voltages ranging from 10,000 to 100,000 volts between this instrument and the usual combination of a voltage transformer and a special high-sensitivity electrodynamic voltmeter showed an agreement to 0.01%. This constituted the first independent confirmation to this high accuracy of the conventional voltage transformer."—Hugh Odishaw, National Bureau of Standards.



1938. "The Magne-Gage for measuring the thickness of coatings was developed by Dr. Abner Brenner of the NBS. The instruments are made by the American Instrument Co. and calibrated at the NBS. About 3000 are in use. Four types of coatings may be measured with an accuracy of ±10%: (1) Magnetic coatings, such as nickel, on a non-magnetic metal like brass; (2)

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Model 59

2.2 mc. to 400 mc.

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Radio's newest, multi-purpose instrument consisting of a grid-dip oscillator connected to its power supply by a flexible cord.

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SPECIFICATIONS:

Power Unit: 5⅛" wide; 6⅛" high; 7½" deep. Oscillator Unit: 3¾" diameter; 2" deep.

FREQUENCY:
2.2 mc. to 400 mc.; seven plug-in coils.

MODULATION:
CW or 120 cycles; or external.

POWER SUPPLY:
110-120 volts, 50-60 cycles; 20 watts.

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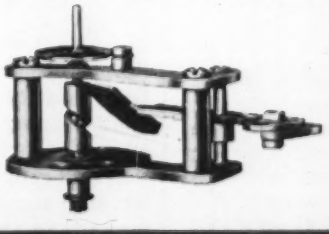
PAY OFF!

On a compressor like this, where you have vibration and rapid pressure pulsations, ordinary gages with clock gear movements last but a short time. Sometimes the gears are worn out in a few weeks.

By comparison, Helicoid gages wear for years. Actually, the gages shown here have been in service for 2½ years and are still going strong.

This is an example of the saving in maintenance which can be made by using Helicoid—the gage of enduring accuracy.



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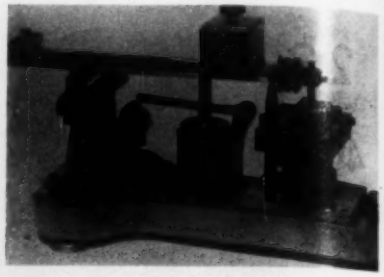
Non-magnetic coatings on iron or steel; (3) Magnetic coatings, such as nickel, on iron and steel; (4) Composite coatings, consisting of a layer of copper and a layer of nickel, on steel. —Hugh Odishaw, National Bureau of Standards.



1938. "Microhardness Measuring Instrument developed by the NBS applies a known load to a diamond indenter cut in the form of an elongated four-sided pyramid to make a diamond-shaped indentation in the material under test . . . With this instrument the hardness of thin metal layers down to 0.00001" thick, brittle material like glasses, crystals, minerals and even diamond, which are beyond the scope of other testers, can be measured quantitatively."—Hugh Odishaw, National Bureau of Standards.

1939. "The first DuMont television sets were produced."—J. H. Ruiter, Allen B. DuMont Laboratories.

1939. "'Dynamometer': No other of its small size, ruggedness and low cost." —R. E. Dillon, W. C. Dillon & Co.

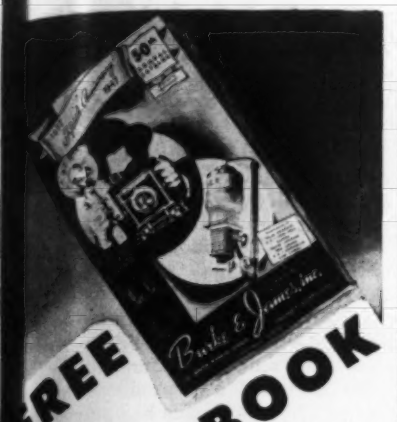
1939. "'Multi-Low-Range Tester': First compact inexpensive all-purpose tester for 100-pound range."—R. E. Dillon, W. C. Dillon & Co.

1939. ". . . a companion instrument to the 'Vibrotest,' the 'Vibroground' . . . obtaining measurements previously taken only with foreign instruments..." —J. F. Inman, Associated Research, Inc.

1939. "Bailey Flame Detector . . . automatically sounded alarm, warning operators to shut off fuel feed in case of ignition failure, thereby preventing possible explosions."—E. B. Bossart, Bailey Meter Co.

1939. "United Electric Controls Co. embarked on the policy of developing specialized electric pressure and temperature controls for individual customer requirements. . . . [see 1940 and 1943]"—E. C. Clark, Jr., for United Electric Controls Co.

1939. "Baldwin's Templin Stress-Strain Recorder was improved in overall accuracy of load recording, and the load-recording element simplified, by replacing the Bourdon tube with a direct mechanical connection from the



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Metal Turning Made Easy with New Simplified Tool!

A new tool called "Tru-Turn" makes possible the conversion of drill presses, woodturning lathes, or grinder stands into tools that will turn and cut-off steel, bronze, copper and aluminum. The "Tru-Turn" tool shown above is mounted on a Buffalo Drill Press, Spindle Size.

The "Tru-Turn" tool is easy to operate and cuts and turns bar stock of steel, bronze, copper and aluminum measuring ¼", ⅜" and ½". Its built-in micrometer permits adjustments that give tool-room accuracy to 1/1000 inch.

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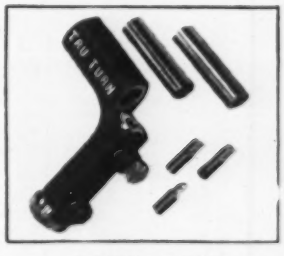
Accurate, precision work is also easier to do when tension is relieved by chewing gum. The act of chewing gum seems to make the work go easier, faster—thus helping on-the-job efficiency. For these reasons Wrigley's Spearmint Chewing Gum is being made available more and more by plant owners everywhere.



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servomotor of the Tate-Em[illegible]y load i[illegible] dicator."—M. G. Van V[illegible]orhis, f[illegible] Baldwin Locomotive Works

1939. "Another in the TAG 'Cel[illegible] tray' potentiometer-pyrome[illegible]er series . . . Multiple Indicating Controll[illegible] which employed but one control syste[illegible] to control up to six points simultan[illegible] ously at a rate of 2 seconds per point —George Terhune, C. J. Tagliab[illegible] Mfg. Co.

1939. "Apparatus for the Kli[illegible] Blood Test, both the slide rotator a[illegible] the ring maker for imprinting slide[illegible] was designed and produced by Ebe[illegible] bach. This apparatus has played an i[illegible] portant part in detection and contr[illegible] of syphilis."—L. B. Bittman, Eberba[illegible] & Son Co.

1939. "The 'Silver King' Mechanic[illegible] Counters featured a revolutionary d[illegible] sign contributing to smooth, effortle[illegible] operation, dependability and long we[illegible] life . . . One-piece Plastic Number Whe[illegible] 85% lighter than metal and celluloid asse[illegible] blies commonly used; Unbreakable pla[illegible] windows; All-steel housing; Modern des[illegible] —for example only one screw is used in t[illegible] counter assembly; Accurate counting at [illegible] speeds up to 500 counts per minute."—R. [illegible] Allbright, for Production Instrument Co.

1939. "Bailey Oxygen Recorder wi[illegible] electronic type recording instrume[illegible] and catalytic-combustion principle a[illegible] alyzer . . . quickly applied to boil[illegible] furnaces, industrial furnaces, kilns, a[illegible] chemical processes as it enabled oper[illegible] tors to maintain the correct amount [illegible] oxygen . . . particularly valuable f[illegible] the firing of mixed fuels."—E. B. Bo[illegible] sart, Bailey Meter Co.

1939. Correlation of Derivative a[illegible] Reset Actions. "The 'Model 30 Stabil[illegible] Controller,' appearing this year, repr[illegible] sented important advancements in co[illegible] troller design. In this instrument d[illegible] rivative action and reset action (H[illegible] per-Reset) were first introduced as co[illegible] related functions, adjustable simultan[illegible] ously by a single operation."—Robe[illegible] Barton, The Foxboro Co.

1939. "The first automatic voltag[illegible] regulating transformer, the size, weig[illegible] and operating characteristics of whi[illegible] made it practical for use as a co[illegible] ponent of electrical and electron[illegible] equipments. . . . immediately made po[illegible] sible and practical the a-c. operati[illegible] of a whole series of electrical and el[illegible] tronic devices . . . hitherto limited [illegible] their application . . . "—C. H. Hum[illegible] Sola Electric Co.

1939. "The Kimble '58' funnel w[illegible] developed. (Previously, manufacture[illegible] attempted to make funnels with a bo[illegible] angle as near to 60° as possible. Then t[illegible] chemists, to get reasonable filtering spe[illegible] developed odd methods of folding the pap[illegible] with the object of having the paper a[illegible] funnel in contact only at or near the t[illegible] These older blown funnels frequently d[illegible] parted significantly from the old standa[illegible] angle of 60° so that variations in manu[illegible] of folding the paper were necessary f[illegible] nearly every funnel.) The easiest way [illegible] fold a paper is in even quadrants, so t[illegible] angle of the bowl was decreased, giving t[illegible]

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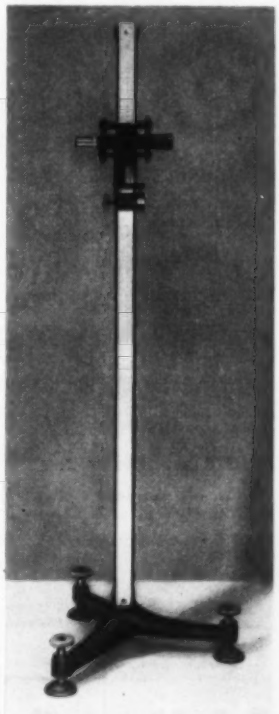

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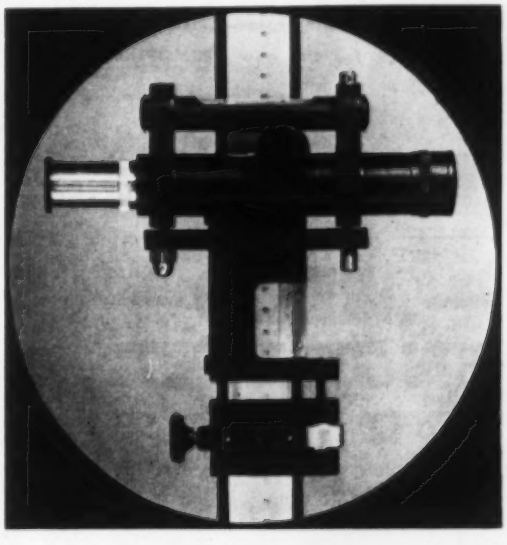

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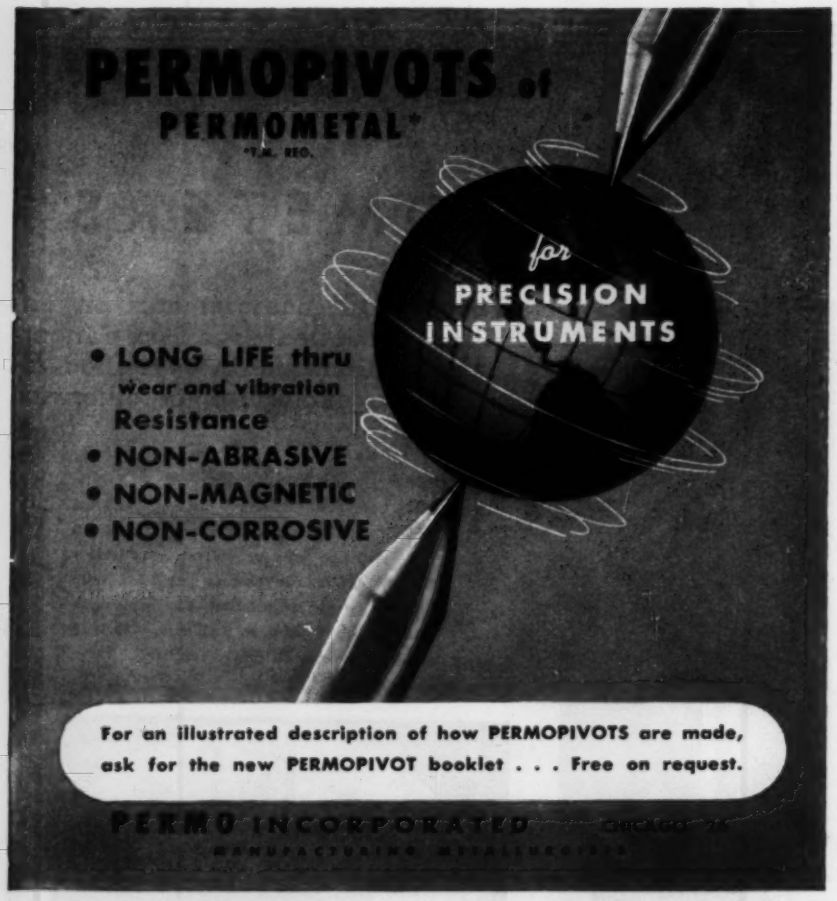

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same effect. At the same time [illegible] the bowl to the exact angle desi[illegible] imately 58° 30') was decided [illegible] Moran, Kimble Glass.

1939. "The Thwing-Albert Ink[illegible] ometer: only instrument which meas[illegible] ures the tack and consistency of print[illegible] ing and lithographic inks under condi[illegible] tions simulating those found in pres[illegible] rooms. . . . This often results in a[illegible] increase in press speeds up to 60[illegible] with the original equipment!"—F. W[illegible] Eitzel, Thwing-Albert Instrument Co.

1939. "The Bristol Co., starting i[illegible] 1939, did a considerable amount of de[illegible] velopment work in combining pH meas[illegible] uring systems already on the marke[illegible] with the Bristol Pyromaster Potenti[illegible] ometer for continuously recording an[illegible] automatically controlling pH value[illegible] This involved a great deal of develop[illegible] ment work in connection with the ap[illegible] plication of pH instruments in indus[illegible] try."—G. P. Lonergan, The Bristol C[illegible]

1939. "The Baldwin 'SR-4' Bonde[illegible] Resistance Wire Strain Gage present[illegible] ed a revolutionary device for determin[illegible] ing strains in structures and machine[illegible] under conditions that had been difficul[illegible] or prohibitive before. . . . almost idea[illegible] because it lies in a plane, is almos[illegible] without mass, easily attached, and lin[illegible] ear in response. . . . bonded metalli[illegible] filament . . . changes its electrical re[illegible] sistance under strain. . . . portabl[illegible] Wheatstone bridge for static use, . . [illegible] high-fidelity amplifiers and oscill[illegible] graphs for dynamic tests. . . ."—M[illegible] G. Van Voorhis, for Baldwin Locomo[illegible] tive Works.

1939. "Ashcroft introduced the firs[illegible] 'K' Monel Bourdon tubes for pressur[illegible] gages. . . . for services that would co[illegible] rode stainless steels. Ashcroft brough[illegible] out the first laminated phenol dials on whic[illegible] the graduations were covered by a clea[illegible] plastic surface, permitting scrubbing an[illegible] cleaning of the dials without disturbing th[illegible] graduations. American introduced Dial Ther[illegible] mometers and Thermal Alarms with high[illegible]

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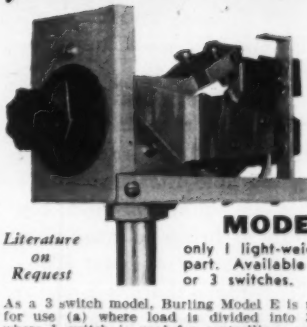
GENERAL ELECTRIC

BURLING TEMPERATURE LIMIT SWITCHES



NO LIQUIDS • NO GASES

Literature on Request

MODEL E

only 1 light-weight moving part. Available with 1, 2 or 3 switches.

As a 3 switch model, Burling Model E is recommended for use (a) where load is divided into 3 parts, (b) where 1 switch is used for controlling, one as a high limit, one as a low limit, (c) to give definite stops on position to a 3 or 4 position diaphragm motor, (d) to give 3 speed control of variable speed motor.

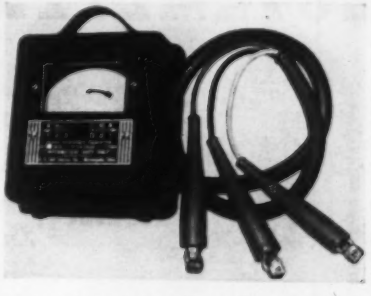
Accurate, rugged, dependable. Corrosion and heat resisting tube. Dial pointer for easy setting. Locking screw locks temperature setting. Increased adjustable range to 700-1000°. Dimensions: 7¼" x 2¾" x 3½". Vapor tight base and cover with gasket available at slight extra charge.

INSTRUMENTS ALSO BUILT TO SPECIFICATIONS

Making Precision Controls for over 11 years

BURLING INSTRUMENT CO.
251C Springfield Ave.
Newark, N. J.

QUICK POSITIVE READINGS WITH THE NEW SELCO



PHASE ROTATION INDICATOR

50 to 600 volt, 25 to 400 cycles, 2, 3, or 6 phase
Model 32B . . . $52.00 F.O.B. MPLS.

- The SELCO Indicator gives you quick positive readings. Avoids costly mistakes.
- Indicates immediately phase sequency by numerical, alphabetical, color coding, and CW-CCW methods.
- Compact and lightweight. Only 5½" x 6" x 3". Weight 3½ lbs.
- Ideal for utilities, contractors, industrial plants, electrical manufacturers, and others.

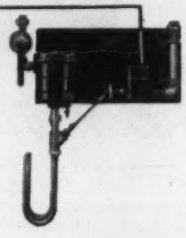
Send for FREE Bulletin No. 728

H. H. SELL ELECTRIC CO.
1909 Willow Ave. No.
MINNEAPOLIS 11, MINN.

Instrumentation News

FUEL IS EXPENSIVE! FUEL IS SCARCE! DON'T WASTE IT!

The NEW DAVIS CONTINUOUS INDICATING AND RECORDING GAS ANALYZER will help you save many dollars in wasted fuel.



IT'S ACCURATE—DEPENDABLE—SIMPLIFIED

Maintenance is cut to a minimum.

Bulletin No. 1136A gives full details. Write for it today!

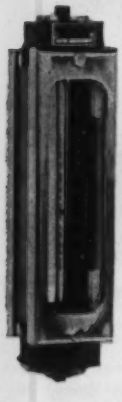
INSTRUMENT DEECO DIVISION

DAVIS EMERGENCY EQUIPMENT CO., INC.

80 Halleck Street, Newark 4, N. J.

The Full-View

ROTAMETER



Certified accuracy!

We use every precaution to protect the high accuracy of our meters. Each direct-reading Full-View rotameter is individually calibrated for the service for which it is intended and a hand-cut flow scale engraved at our Plant for it. By this means we are producing rotameters of certified accuracy for the chemical industry. If you want accurate flow rate measurement, write for Folder No. 20.

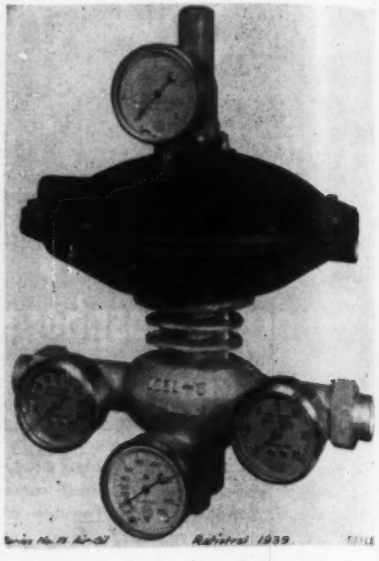
BROOKS ROTAMETER CO.

BOX A-5248 LANSDALE, PA.

SALES MANAGER WANTED: by medium sized industrial instrument manufacturer. Established products of many years' standing sold nationally mostly from home office and through agents. The man we are looking for must know instruments such as: thermometers, recorders, air and electrical controllers, self-operated controllers, dials, and know the price field thoroughly. He should be qualified and big enough to bring in profitable annual sales of at least $500,000.00. Perhaps there is a junior who is at present assistant to a busy sales manager and feels he cannot advance farther and would like to prove his ability and qualifications for a national sales job himself. Location Detroit. Full details will be held in strictest confidence. Box 145, Instruments Publishing Company, 1117 Wolfendale Street, Pittsburgh 12, Pa.

sensitivity bulbs for use on separately-fired superheater service. These operated without separable sockets and responded almost instantaneously to rapidly-fluctuating temperatures and prevented damage to the superheater."—S. Goodwin, Manning, Maxwell & Moore.

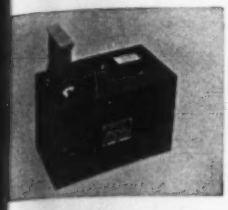
1939. " . . . founding of Measurements Corp. by a group of radio engineers experienced in the development of . . . electronic laboratory standards. Within a few months . . . offered the first of a long series of outstanding instruments that heretofore had not been available commercially. . . . 'Model 54' was the first Standard Signal Generator to be manufactured having built-in motor tuning. . . . "—E. M. Weed, Measurements Corp.



1939. "Oil-Air 'Ratiotrol,' . . . to proportion oil to air for proper combustion in industrial furnaces. . . . a single yet more accurate proportioning device . . . Individual burners may be added or taken away, or burner adjustments may be made without changing the air-oil ratio of other burners on the same control. This was not possible with proportioning controls in use previously . . ."—H. L. Jenkins, North American Mfg. Co.

1939. "The Bristol Co. in conjunction with the Weston Electrical Instrument Corp. perfected the Bristol 'Thermoverter,' a totalizing instrument which makes it possible to measure a-c. power with a potentiometer or millivoltmeter. . . . Among purposes: measuring the a-c. power in an individual circuit; totalizing the a-c. power in a

Ask SEEDBURO about MOISTURE TESTING



Present your moisture problems to Seedburo . . . headquarters for moisture testing "know how" since 1912. No charge for study and recommendations.

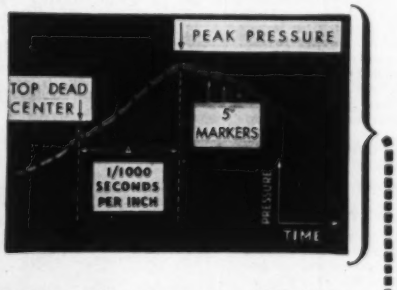
Seedburo technical men have solved moisture analysis difficulties related to grains, nuts, dehydrated foods, cocoa, cotton linters, silica gel, zeolite and numerous other products. Quite likely they can help you. Their recommendations are unbiased because Seedburo handles a wide selection of moisture testers—one for every need. The Steinlite one minute moisture tester is fast, accurate, easy to use. Calibrated against official oven methods.

SEEDBURO EQUIPMENT COMPANY

744 CONVERSE BUILDING
CHICAGO 6, ILLINOIS

Have you ever seen the INSIDE of an EXPLOSION?

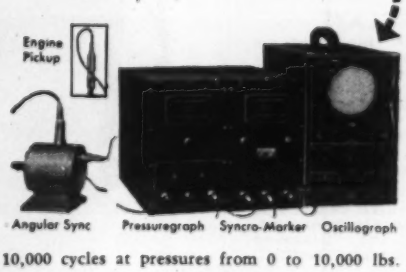
OR RATE OF FLAME PROPAGATION?



SEEING NOW MADE POSSIBLE BY REMARKABLE NEW ELECTRONIC FEATURES OF

PRESSUREGRAPH with Syncro-Marker

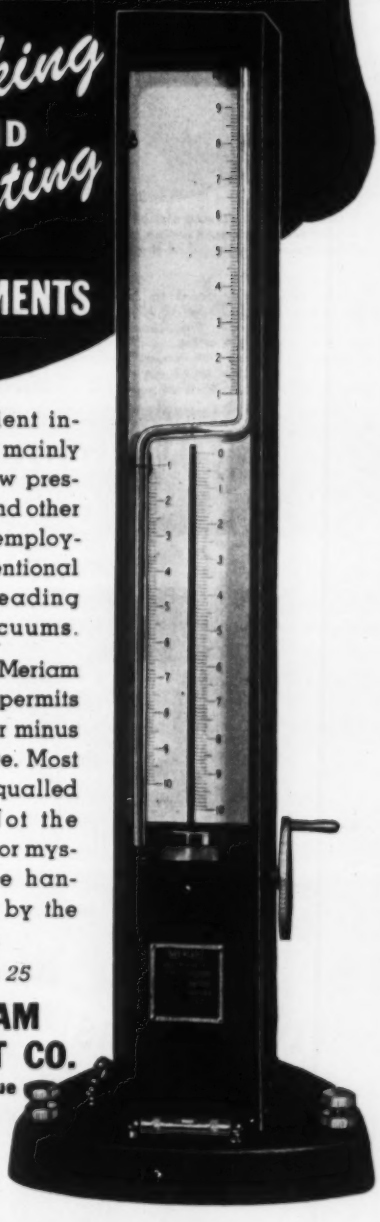
Reproduces on oscillograph screen, accurate picture of pressures during and after explosion, relates pressure variations to time, top dead center, angular velocity, etc. Also accurate tracing of rate of flame propagation. See pressure-time characteristics of automotive, jet and Diesel engines, also compressors, pumps, etc. Operates over range from static up to 10,000 cycles at pressures from 0 to 10,000 lbs.



Send for description and full engineering data

ELECTRO PRODUCTS LABORATORIES
549 W. RANDOLPH ST., CHICAGO 6, ILL. *Phone STAte 7444*

AND NOW THE MERIAM MICROMANOMETER FOR Checking AND Calibrating INSTRUMENTS



● This new, efficient instrument is used mainly for calibrating low pressure instruments and other devices. It can be employed also as a conventional manometer for reading pressures or vacuums.

Highly sensitive, the Meriam Micromanometer permits readings to plus or minus .001" water pressure. Most rugged, and unequalled in simplicity. Not the least complicated or mysterious, it can be handled successfully by the average operator.

Ask for Bulletin 25

THE MERIAM INSTRUMENT CO.
10958 Madison Avenue
Cleveland 2, Ohio

Patent Applied For

MERIAM *Instruments*
ESTABLISHED 1911
MANOMETERS, METERS AND GAUGES FOR THE ACCURATE MEASUREMENT OF PRESSURES, VACUUMS AND FLOWS OF LIQUIDS AND GASES

BEAT FREQUENCY GENERATOR

TYPE 140-A

FREQUENCY COVERAGE

20 cycles to 5 mc.

The six inch frequency dial of the Type 140-A Beat Frequency Generator has been planned for maximum readability and rapid setting, with combined scale lengths of the low and high ranges exceeding 22 inches. Continuous coverage of the entire audio spectrum is possible without bothersome range switching.

SPECIFICATIONS:

Frequency Range: 20 cycles to 5 megacycles in two ranges. *Low Range:* 20 to 30,000 cycles. *High Range:* 30 kc to 5 megacycles. *Frequency Calibration:* Accuracy ±2 cycles up to 100 cycles, ±2% above 100 cycles. *Adjustment:* High and low ranges have individual zero beat adjustments. Low range may be checked against power line frequency with front panel 1 inch cathode ray tube. *Output Power and Impedances:* Rated power output: one watt, available over the low frequency range from output impedances of 20, 50, 200, 500, 1000 ohms, and over both ranges from an output impedance of 1000 ohms. *Output Attenuator:* Five steps: X1.0, X0.1, X.01, X.001, X.0001. Distortion: 5% or less at 1 watt output; 2% or less for ½ voltage output. ***Write for Catalog "D"***

BOONTON RADIO Corporation

BOONTON N.J. U.S.A.

DESIGNERS AND MANUFACTURERS OF THE Q METER — Q× CHECKER FREQUENCY MODULATED SIGNAL GENERATOR BEAT FREQUENCY GENERATOR AND OTHER DIRECT READING INSTRUMENTS

DIFFERENTIAL PRESSURE INDICATOR MODEL 181

- 6" HIGH VISIBILITY DIAL
- RANGES 0-50 INCHES OF WATER UP TO 0-200 P.S.I.
- PRESSURE RATINGS UP TO 3000 P.S.I.
- UNIVERSAL MOUNTING
- RUPTURE-PROOF BELLOWS UNIT

Write for Bulletin 181-1

BARTON INSTRUMENT COMPANY

3500 UNION PACIFIC AVE. LOS ANGELES 23, CALIF.

Automatic ELECTRIC PRODUCTS

TIME SWITCHES

Ruggedly constructed *Automatic* Switches have visible dial in tamper proof compact cabinet . . . pure silver contacts . . . 2 to 24 "on" and "off" operations. For any load . . . for every installation an *Automatic* time switch or Interval Timer will deliver superior performance.

Synchronous or Manually Wound

FLASHERS

Automatic heavy duty, motor driven Flashers available in circuit arrangements for every conceivable effect. Pure silver contacts. Models for any load or purpose.

Alternates *Chasers* *Spellers*

RELAYS

Automatic manufactures a complete line of dependable relays for industrial, business machines, radio, electronic and many other uses . . . open, or can type with tube-base, plug-in features.

Consult our Engineering Department

WRITE FOR SPECIFICATIONS AND INFORMATION TODAY

In Switches, Flashers and Relays where dependable performance is paramount, look for the "Diamond Seal for Diamond Quality".

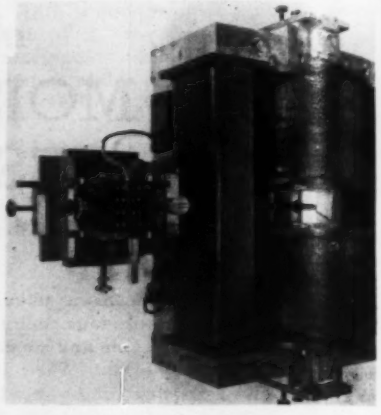
WRITE TODAY!

AEMCO

Automatic Electric MFG. CO.

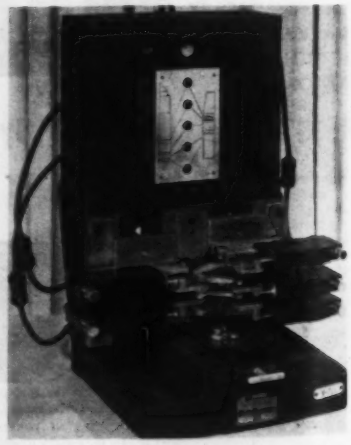
58 STATE ST., MANKATO, MINNESOTA

number of circuits; telemeter ing a-c. power or totalized load. It performs a proportional conversion from a-c. watts to d-c. millivolts. Outstanding feature is speed: less than 0.5 sec. time of response between a change in a-c. power load and development of proportional emf."—G. P. Lonergan, The Bristol Co.



1939. "The NBS High-*H* Permeameter, designed to meet the need for magnetic testing at magnetizing forces considerably higher than previously attainable in testing apparatus, can be used to make accurate measurements at magnetizing forces up to 5000 oersteds. Developed by Sanford and Bennet of the NBS."—Hugh Odishaw, National Bureau of Standards.

1939. "Development of smooth landing systems, accurate radars, and highly directive television relay links belongs to the era of microwave power . . . Invention of the Klystron by the Varian brothers opened this new era by offering the first satisfactory method of generating continuous microwave power in practical quantities. Sperry picked up development and in 1939 introduced its first klystron. . . . flexibility of the klystron stands unmatched in the microwave world. . . ."—C. H. Jones, Sperry Gyroscope Co.



1939. "The Sheffield 'Multichek' or multiple electric gage measures a number of dimensions simultaneously. Tolerance is adjustable and is accurate within ten millionths of an inch. This

AMP

SHUR-PLUG

Solderless Replacement Terminals for "Snap-in" Disconnect Connections

- For instrument panel wiring, relays, lights, etc., on cars, trucks and buses.
- For automatic controls on washers, ranges, dishwashers, radios, air conditioning units, etc.
- For relays, controls, lights, etc., on tractors and other industrial material handling equipment.

AMP "SHUR-PLUGS" provide easy convenient replacement of "snap-in" terminals without fuss or hazards of soldering. Applied in matter of seconds by AMP hand tools, pneumatic-powered hand tools or foot or power-operated presses using positive, permanent AMP pressure crimp. Superior to soldered connections in strength, conductivity and corrosion resistance.

AMP "SHUR-PLUGS" are available for standard 16-14 stranded wire and are designed to make perfect "snap-in" connections with standard female fittings.

Catalog Section 52 gives you complete details — write today for your copy.

AIRCRAFT-MARINE PRODUCTS Inc.
2506 NORTH FOURTH STREET, HARRISBURG, PA.
Sole Canadian Representative:
H. MANLEY & SONS, LTD., 82 Adelaide St., E., Toronto, Ont., Canada

FOR ECONOMY AND SAFETY

POWERS

Water Temperature Control

for
HOT WATER HEATERS
•
INDUSTRIAL PROCESSES
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SHOWER BATHS
•
HOSPITAL HYDRO-THERAPY
•
PHOTO DEVELOPING
etc.

GET A COPY OF CATALOG No. 3035. This new catalog shows the most complete line of water temperature controls made . . . capacities ranging from 1 to 10,000 gallons per minute. Whenever you have a problem of water temperature control just phone or write our nearest office. With over 50 years of experience, we can help you get the best type of control for your requirements.

Chicago, 2734 Greenview Ave.
New York, 231 East 46th St. Los Angeles, 1808 W. Eighth St.

THE POWERS REGULATOR CO.
Offices in 47 Cities • See Your Phone Book

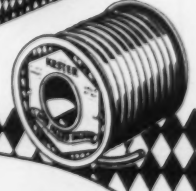
How to Increase Profits Cut Costs

USE KESTER SOLDER

Today high labor costs are a major problem. Increase the efficiency of your production by using Kester Cored solders. A top quality product with a dependable and uniform flux core which will increase the speed of all soldering operations.

Use Kester Acid-Core solder for general work; Kester Rosin-Core solder for all electrical work.

Be Sure With Kester

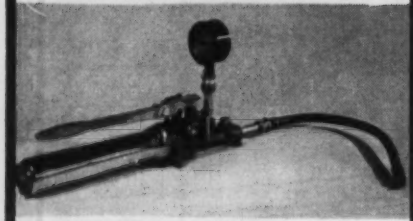


KESTER SOLDER

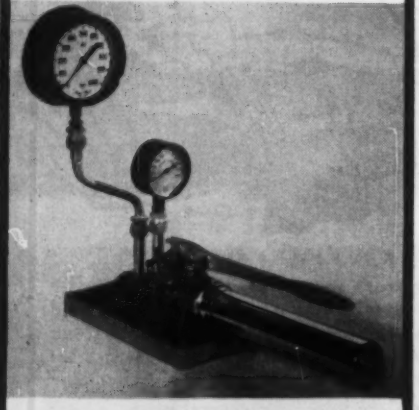
KESTER SOLDER COMPANY
4216 Wrightwood Avenue, Chicago 39, Illinois
EASTERN PLANT: NEWARK, NEW JERSEY • CANADIAN PLANT: BRANTFORD, CANADA

WHY BUY 3 UNITS
when
1 TWIN SEAL UNIT WILL SERVE 3 WAYS

10,000 psi—no leakage or seepage



1 PORTABLE PRESSURE TESTING
Weight, filled with oil, 8½ lbs.



2 BENCH WORK WITH TEST GAGE
mounted on aluminum drip pan

3 DEAD WEIGHT TESTING
shown with dead weight attachment mounted on unit.
Write for Bulletin

MANSFIELD & GREEN
1051 Power Avenue CLEVELAND 14, O.

High precision OPTICAL PARTS for Research, Development or Production.

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PARABOLIC or SPHERICAL Mirrors.

•

LENSES, PRISMS or related components for your visual, photographic or electronic requirements.

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Natural or Synthetic CRYSTAL OPTICS.

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Complete optical INSTRUMENTS.

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Vacuum Coating of Optical Parts.

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John Unertl Optical Co.
3551-3555 East Street
Pittsburgh 14, Penna.

CLEANING?

Don't tear down your instruments!

The ENG-SOL Method of Precision Parts cleaning now makes it possible to whisk away fingerprints, oil, grease, dirt, lapping compounds, abrasives, lint, or other contamination.

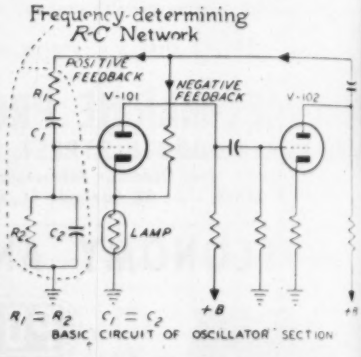
Our bulletin "Precision Cleaning" describes this new high-velocity compressed air method of cleaning.

Send for it—today.

PASSAIC ANALYTICAL LABORATORIES, Inc.
228 Aycrigg Ave. Passaic, N. J.

particular instrument, now in the Smithsonian Institution . . . inspected 5,815,665 37-mm. shells at Frankford Arsenal between 1940 and 1944, a total of 29,078,325 dimensions . . . saved 4,000 days' work over previous hand gaging methods."—C. W. Hamilton, Sheffield Corp.

1939. "The Hewlett-Packard Co. was founded to manufacture the oscillator invented and developed by William R. Hewlett . . . a new approach to the problem of audio oscillators . . . performance considerably superior to instruments previously available, many of them at several times the price of the *-hp-* instrument. We believe that this oscillator represented a great contribution to the electronic and measurement fields . . . a stable, reliable source of audio and low radio frequencies. During the war this fundamental circuit was used in many types of radar equipment, underwater sound equipment [etc.]. Because of its stability, flexibility and ease of construction . . . universally accepted and used. . . . The fundamental resistance-tuned circuit of the *-hp-* '200 series' audio oscillators is shown in the sketch (our only item for *Instruments*' chronology).



$R_1 = R_2$ $C_1 = C_2$
BASIC CIRCUIT OF OSCILLATOR SECTION

The resonant frequency of this network is inversely proportional to the product of resistance and capacitance. Thus the change in resonant frequency of this circuit is three times as great as that of the coil-and-capacitor circuit. A ten to one frequency change is easily possible with the resistance-tuned circuit. The *R-C* frequency-determining network is operated in conjunction with a stabilized amplifier. Positive feedback is applied to this amplifier through the resistance-tuned network, resulting in a high effective *Q* for the circuit. Negative feedback . . . operates in conjunction with a non-linear resistor to limit amplitude and decrease distortion. It also helps provide a constant and extremely stable output over the entire range. This company has offered the circuit to the public in many combinations . . . While other instruments developed by this company have made great contributions to the measurements industry we believe that the '200 series' oscillator is the most far-reaching . . ."—W. N. Eldred, Hewlett-Packard Co.

1939. "A Pupillometric Exposure Meter, developed by J. B. Saunders of the NBS, is a screen with opaque and transparent areas so shaped and spaced as to serve as an accurate and sensitive measure of the pupil size, which, when measured and calibrated, serves as a measure of light values for photographic exposures. The size of the pupil is compared with the several different sizes of opaque disks by noting the smallest disk that yields an umbral shadow on the retina. The device is calibrated against the reaction of the pupil to known illuminations. Patent applied for under Serial No. 198 586."—Hugh Odishaw, National Bureau of Standards.

To be concluded. *See page 127*

Draft Gages in PRACTICAL, CONVENIENT and Economical SIZES

HAYS offers a complete line of pointer type draft gages designed to fit every need and every budget.

No longer is it necessary to buy a large gage when a small one is available that will serve quite as well or better. No longer need you try to make one size gage handle all drafts.

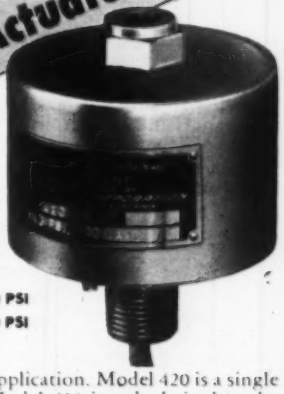
All these gages have the famous Hays slack diaphragm unit for ranges of draft or pressure from 0 to 120 inches of water. For ranges above 100 inches, Bourdon Tubes are used. For full description of these better gages, in all sizes and ranges, send for Bulletin 45-667.

The HAYS CORPORATION

COMBUSTION INSTRUMENTS AND CONTROL

MICHIGAN CITY, INDIANA, U.S.A.

New Tamper-Proof Pressure Actuated Switch



Manual Reset Available
Compact
Withstand Pressures to 150 PSI
Operating Pressures to 100 PSI
Operating Range—Vacuum to 100 PSI
Differentials—3" water to 20 PSI

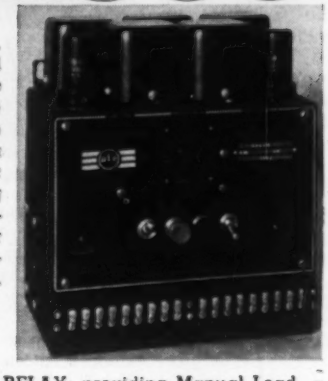
Designed for wide industrial application. Model 420 is a single pole, double throw switch; Model 430 is a dual single pole, double throw switch. Economical low-current operation. Operator cannot tamper with this dustproof switch, yet sealed lock ring permits convenient adjustment. Protected against atmospheric corrosion. This durable, accurate switch will withstand total vacuum. Our engineering staff stands ready to work with you on your specific applications. Write today!

MELETRON CORPORATION

MANUFACTURERS OF *George A. Starbird* EQUIPMENT

Dept. A-1, 950 North Highland Avenue, Los Angeles 38, Calif.

ELECTRONIC PROPORTIONING RELAY



NOW . . . an improved industrial type PROPORTIONING RELAY utilizing the sensitivity of a proven electronic circuit for providing prompt corrective movements of devices used for the regulation of temperature, pressure, flow, etc.

2 TYPES AVAILABLE

1. RELATROL RELAY: providing Manual Load Compensation feature. Requires 100 ohm slidewire in actuating instrument and valve operator.
2. BALANCER RELAY: features Automatic Load Compensation (reset). Actuating instrument requires 100 ohm slidewire plus "H" and "L" contacts.

Request Complete Data

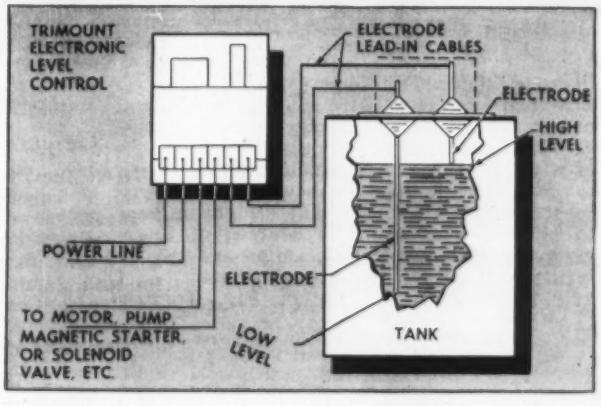
TIMERS: STANDARD LINE AND SPECIAL

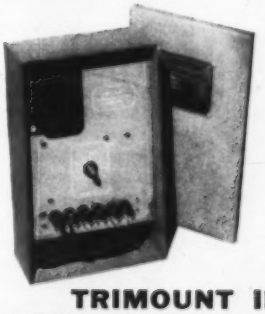
atc

AUTOMATIC TEMPERATURE CONTROL CO., INC.

5212 PULASKI AVENUE • PHILADELPHIA 44, PA.

AUTOMATIC *Electronic* LEVEL CONTROL





For Open and Closed Tanks, Pipe Lines, Sumps, etc.

Improved design with adjustable conductance control. For all liquids. Dependable. Positive. Safe. Can be used in multiples. WRITE for bulletin 141.

TRIMOUNT INSTRUMENT CO.

37 W. Van Buren St. Chicago 5, Ill.

The Month's NEW INSTRUMENTS

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 18

Oxygen Recorder

New "Magno-Therm" continuously indicates the percentage of oxygen in industrial gases, utilizes new non-chemical mehod based on oxygen's high paramagnetism as sketched in Fig. 1. Magnetic convection current being proportional to percent of oxygen in the continuous sample, cooling of wire

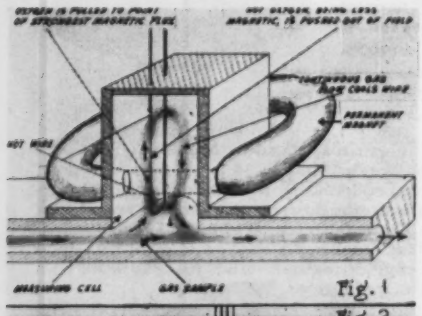


Fig. 1

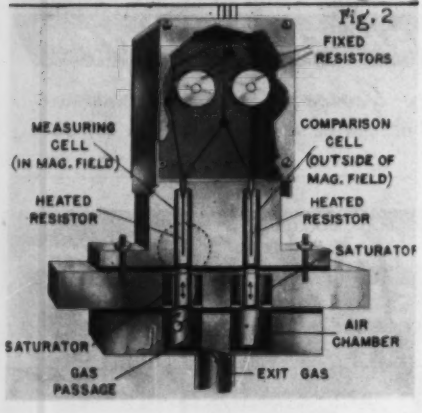


Fig. 2

likewise depends on this percent; therefore, temperature of wire is a function of oxygen percent when other factors are kept constant and measurement of wire resistance is a measurement of oxygen percent. Fig. 2 shows actual construction of analyzer unit designed to eliminate or minimize sources of error. In each instrument, entire analyzing section is fibreglass-insulated and thermostated at 130°F. Fig. 3

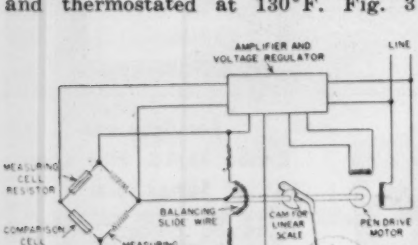
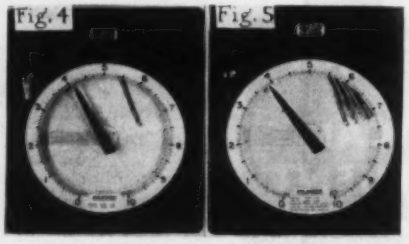


Fig. 3

shows self-balancing circuit and servo-driven recording pen. Since relation of wire resistance to percent oxygen is not linear, a properly-shaped cam is



interposed to permit use of printed charts with linear scales. In addition to pen, complete instrument (Fig. 4) features a large power-driven indicating pointer. Several types of gas-sampling systems (not illustrated) are available, such as aspirator type, centrifugal-blower type or positive-displacement-pump type. Accuracy is 0.25% oxygen up to 20%; or 2.5% of range up to 100%. Minimum recorder range is 0-5%. Glass-coated measuring wires and other refinements minimize risk of loss of calibration; minimal maintenance is assured by non-chemical method which obviates need of replenishing solutions, cleaning containers, etc. Fig. 5 shows a four-unit recorder; large indicator and Pen No. 1, oxygen 0-10%; other three units as specified (temperature, water level, fan speed, etc.)—*The Hays Corp., Michigan City, Indiana.*

Please mention number 201 when filling out card

Thermocouples

Newly-completed series of pyrometer thermocouples is announced. Latest thermocouple is a closed-end type with a silver tip, said to be suitable for highly accurate temperature readings on hot metal, rubber or plastic surfaces.—*K. H. Huppert Co., 6830 Cottage Grove Avenue, Chicago 37, Illinois.*

Please mention number 202 when filling out card

Geiger-Mueller Tubes

New family of Geiger-Mueller Counter Tubes have been redesigned. Exclusive developments are said to include direct bonds between mica and metal and mica and glass. Tubes are for beta, gamma and x-rays.—*Amperex Electronic Corp., 25 Washington St., Brooklyn 1, N. Y.*

Please mention number 203 when filling out card

Thermocouple Protecting Tube

New "Serv-rite" heavy-wall cast-iron thermocouple protecting tube is reported to have a much longer life and to be more practical and economical than the ordinary cast-iron tube used for molten aluminum, zinc and die-casting metals. X-ray inspection reveals three factors: uniform wall thickness, freedom from casting defects and good welding. New tube is furnished with a ⅜" wall thickness and a 15/16" ID.—*Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.*

Please mention number 204 when filling out card

Strain-recording System

New "Type M" stress-strain recorder is controlled by two "Microformers" (variable miniature transformers) built into strain follower and recorder mechanisms. In operation, changing deformation in specimen actuates movable core of strain-follower "Microformer," unbalancing an electric circuit that in-

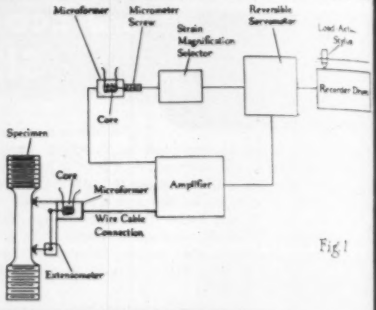


Fig. 1

cludes similar "Microformer" in recorder. Output is amplified to drive a servo-motor which moves core of recorder "Microformer" (thus rebalancing circuit) and rotates recorder drum in proportion to specimen deformation. Corresponding values of applied load are

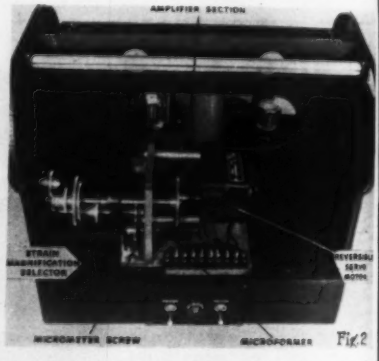


Fig. 2

recorded by movement of stylus parallel to axis of recorder drum, actuated mechanically by testing machine load indicator. Fig. 1 is a schematic diagram of system; Fig. 2 shows recorder mechanism with recorder drum and stylus removed to show amplifier section. Although new system is intended chiefly for strain-recording devices designed to magnify strain 1000× or more, it is also adaptable for recording almost any pair of variables.—*Baldwin Locomotive Co., Philadelphia 42, Penna.*

Please mention number 205 when filling out card

"Outside Temperature" Controller for Buildings

New fully-modulating system of temperature control for commercial and industrial buildings regulates inside temperatures in accordance with changes in outside climatic conditions; is applicable to either hot-water or steam heating plants; supplements maker's "Weatherstat" system. System

JOURNAL of the Instrument Society of America

Editor, R. R. PROCTOR, 2213 Ridge Ave., Evanston, Ill.
I.S.A. National Office, 1117 Wolfendale St., Pittsburgh 12, Penna.

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Vol. 3 — February 1948 — No. 2

Editorial

Conference Statistics

Final figures on the attendance at the Second Annual Instrument Conference and Exhibit in Chicago last September were recently released by Secretary Rimbach, and the breakdowns by industry, occupation and location make very interesting reading. It is not our intention to reproduce the complete breakdown chart here, inasmuch as this information is of more value to the exhibitors and prospective exhibitors—and has been sent to them recently. We would like to share with all our readers, however, some of the more interesting figures from these breakdowns.

The total attendance at the Conference was 7086, of which 6555 were classified from the McBee Keysort registration card file. 124 foreign visitors, 139 students, 193 registrants' wives, 33 publications and 12 advertising agencies registered to make up the total of 7086, but were not classified in the final tabulation.

By occupational breakdown, it is interesting to note that 193 presidents, 137 owners and 164 vice-presidents of various concerns were in attendance. By far the largest occupational group represented (and this is significant) was the 1265 plant, maintenance, electrolysis, packaging and industrial engineers! The next largest group consisted of 896 sales engineers and sales-advertising managers. 238 directors of research, 224 design engineers, 221 instrument department superintendents, 200 general superintendents, 197 chief engineers and 129 instrument engineers registered, as well as several hundred other executives, engineers and technicians in other classifications.

These figures are admittedly picked from the chart for a purpose—that of indicating the high caliber of the people attending the Conference and Exhibit. However, when it is considered that the clerks, stenographers, secretaries, "miscellaneous" and untitled visitors totalled but (approx.) 800, or about 12 percent, and that everyone else in attendance was associated intimately with instruments and instrumentation, we believe we are justified in feeling proud of that showing.

The industrial breakdown shows that of the 1265 plant, maintenance and industrial engineers present, 214 were exhibitors' representatives; another 107 represented instrument manufacturers, mainly those not exhibiting at the Conference.

The largest single group in the industrial breakdown was, naturally, the exhibitors' group—1610. This includes 47 presidents and 67 vice-presidents, 20 owners, 28 directors of research, 85 chief engineers, 51 design engineers, 64 instrument mechanics, 492 sales engineers and 214 industrial engineers. Others in this group range from clerks to executives, classified in 27 other categories. Of the men they did business with, the "customers," the chemical processing industries provided 462, electrical manufacturers 284, food products 261, iron and steel products 354, machinery 487, petroleum products 339, research laboratories 245, and another 1700 or so from other fields (schools, government, institutions, automotive and aircraft industries, and others).

Another interesting breakdown was made on a geographical basis. The East North Centra states (Ohio, Indiana, Illinois, Michigan and Wisconsin) provided the greatest number of registrants—5683. 4536 of these were from Illinois alone. The next largest group came from the Middle Atlantic states (New York, New Jersey and Pennsylvania)—624.

Except for Illinois, Indiana sent the largest state delegation — 488. New York with 280 was next, with Pennsylvania competing strongly with 260. Following these came Wisconsin and Ohio, with 235 and 234 respectively, Michigan with 190, New Jersey and Massachusetts with 84 each, and Missouri with 75. Low honors were shared by Kansas, Montana and Mississippi, with 1 each. Other states were represented by from 2 to 50-some each, Canada by 40 and all other countries by 87—for a grand total of 7086 as previously reported.

To obtain further information about the attendance at the Conference and Exhibit, a questionnaire was sent out shortly after the event to several thousand individuals who had registered. Approximately 40% of the completed questionnaires were returned in time to make a January release to the exhibitors, and we believe that some of the facts brought to light are interesting enough to pass on to everyone. For example, the number of days in attendance was approximately as follows:

½ day	— 9%
1 day	— 52%
2 days	— 18%
3 days	— 8%
4 days	— 5%
5 days	— 8%

Another interesting breakdown was the division of time between the technical sessions and the exhibit. 67 per cent of those reporting stated that they spent more time at the exhibits, while only 8 percent spent more time at the meetings. 25% reported that they divided their time evenly between the meetings and the exhibit. (These figures represent only the visitors—not the exhibitors.)

Many more interesting facts and figures can be gleaned from the complete breakdowns, but most of them are of interest primarily to the exhibitors. It can be appreciated that to obtain and tabulate this vital data was no small job, and much credit is due to Secretary Rimbach and his co-workers for the time and effort put into it. The decision to use the McBee Keysort cards (which the Society intends to continue using) for registration purposes contributed greatly to the rapidity with which the final tabulations were obtained; the results of this classification and questionnaire will show up in bigger and better Conference and Exhibits in the future.

So "Make a Date—Philadelphia in '48." Let this be another reminder that the Third National Instrument Conference and Exhibit is to be held in Convention Hall, Philadelphia, from September 13th through the 17th, 1948. See you there. —R. R. Proctor

Editor's Notes

1. Philadelphia Exhibit Space Half Sold

It has just been reported by the Allocations Committee of the Third National Instrument Conference and Exhibit that over half of the available space in Convention Hall, Philadelphia, has already been sold and allocated as of January 20, 1948. Space has been allocated in the order in which reservations were received.

All space allocated at the first meeting of the committee (consisting of Messrs. White, Trapnell, Krieg, Adler and McKinney of the Philadelphia Section) was reserved by exhibitors at previous ISA Conferences, who were given a 30-day priority over new exhibitors. Of the 250 booths available in Convention Hall, 101 have been sold to 68 second- and third-time exhibitors.

2. Press Relations Committee Organized

A Press Relations Committee to handle the publicity for the Philadelphia Conference and Exhibit next September 13-17 has been organized with Mr. H. Cabot as chairman. All cooperating societies will be represented on this committee, but the names of the members were not available at this writing.

Mr. Cabot reports that progress has been made on the contacts with Philadelphia newspapers, that displays are being arranged for in one or two of the larger store windows in Philadelphia prior to and during the Conference, and that plans have been drawn up—and some tentative arrangements already made—for the possible telecasting of two of the ISA meetings! Arrangements for the set-up of a press office have already gotten beyond the discussion stage, with Messrs. Cabot, Grace and Rimbach handling the details.

All in all, it appears that Mr. Cabot and his committee have gotten off to an excellent start, and if the Philadelphia Conference next September doesn't get all the publicity it can use, it will be through no fault of the Press Relations Committee. More power to you, Mr. Cabot.

3. THE *NEEDLE* POINTS TO—

New Jersey, Niagara Frontier and Washington for the most interesting reports, all of which we classify "recommended reading" for everyone. Also smaller needles to Eastern New York, Richland and Southern Michigan for very good reports.

General News

1948 EXHIBIT CONTRACTS MAILED

Contract forms and information concerning the Third National Instrument Exhibit to be held in Convention Hall, Philadelphia, next September 13-17 have been mailed to prospective exhibitors, according to Executive Secretary Richard Rimbach.

In December contracts for exhibit space, plus other literature and the occupational, industrial and geographical breakdowns of the attendance at the Chicago Conference and Exhibit in September, 1947, were sent out to all those who exhibited at the Chicago Conference. This mailing was the first solicitation of reservations for booth space at the Philadelphia Conference, and was in accordance with the agreement made with the Exhibitors' Committee that the Chicago exhibitors be given thirty days prior opportunity for the selection of space.

In January a general mailing of contracts to all prospective exhibitors who did not exhibit at Chicago was made.

Further reports on the progress of the sale of space will be published in the *Journal* as the information is released by the Philadelphia Exhibit Committee.

NEW SECTION ORGANIZED IN RICHLAND, WASHINGTON

On January 1, 1948, the thirty-fifth Section of the I.S.A. was issued its charter, bringing into the Society 91 members from the Richland, Washington, area.

Quoting from the letter of application dated December 12, 1947, and written by the Secretary, B. E. Woodward, "This organization has been formed . . . for the advancement of the various phases of instrumentation. One of the objectives of the organizations is the affiliation with the Instrument Society of America. It is the purpose of this letter to petition the Executive Committee for a Section Charter. . . .

"Two meetings of the organization have been held; the first on November 14, when officers were elected and a program committee appointed. The second meeting was held on December 10, at which Mr. H. D. Middel, Instrument Department Superintendent of the General Electric Company at Richland spoke on 'Instrumentation in Our Future.'

"Attendance at both meetings numbered sixty-five, and since not all of the same interested men were able to attend each one, it appears that we can expect a working membership of at least 75. (Ed Note: 91 signed application blanks were received December 19th) . . . Considerable enthusiasm for the organization is apparent.

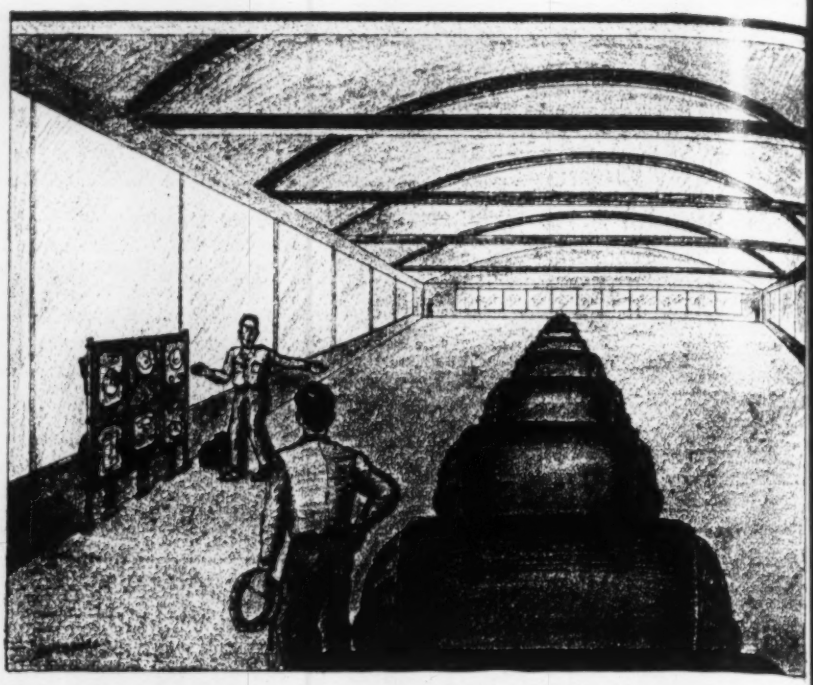
"The Program Committee is planning a very constructive and educational series of meetings, starting with a January meeting on 'Standard Methods of Measurement.' This will be followed by a series on primary elements, followed by detectors, recorders, and finally automatic control. It is anticipated that (this preliminary program will extend over a period of two, possibly three years. In addition to the regularly scheduled meetings, it is planned to take advantage of the presence of distinguished visitors in Richland on occasion, and hold special meetings on shorter notice.

"Pending approval of the Executive Committee, the group has chosen the name 'Instrument Society of America—Richland Section.'

" . . . The officers of our organization are as follows: President, E. S. Day, Jr.; Vice-President, G. G. Matthews; Treasurer, R. W. Lutz; Secretary, B. E. Woodward—all of General Electric Company, Hanford Works, Richland, Washington."

"INDUSTRIAL MARKETING" Lauds Chicago Exhibit

Of the 63 publications which sent representatives to the Second National Instrument Conference and Exhibit in Chicago last September 8-12, "INDUSTRIAL MARKETING" came out with one of the most interesting short write-ups of the event in its October, 1947, issue. Under the title "Instrument Society's $6 Million Show Dramatizes Expanding Controls Market," the article dubs the Instrument Society of America "an infant industry, previously a stepchild of a half a dozen other technical parents . . . the lusty claimant for industrial attention." Comparing the I.S.A. Exhibit to the giant Machine Tool Show which opened at the Dodge-Chicago plant a week later, the article is very complimentary in its description of the Conference and Exhibit.



"Seven acres we got in here—and they hafta go and put this panel smack up against the wall!!!!"

Of equal interest to "Industrial Marketing" was the registration system used at the Conference. The article says, "Industrial Marketing's unofficial blue ribbon for the neatest exhibit trick of the year goes to the (Second) National Instrument Conference and Exhibit held in Chicago, September 8 to 12. The trick is the copyrighted invitation and registration card employing the McBee Keysort system for classifiying visitors by industry, occupation and location. . . . "

A reprint of this article, which includes illustrations of several of the larger exhibits at the Chicago show, has been sent to each prospective exhibitor at the 1948 Philadelphia show. Others who would like to read this article may find it in the October, 1947, issue of "Industrial Marketing," page 47.

AIEE CONFERENCE ON INSTRUMENTATION IN PHILADELPHIA IN MARCH

The American Institute of Electrical Engineers has announced its plans for a "Conference on Electron Tubes for Instrumentation and Industrial Use" to be held in Philadelphia, March 29, 30 and 31, 1948, according to Mr. Warren H. Tidd of Bell Telephone Laboratories, New York City, Publicity Chairman.

Further details were not available at this writing, but because it is probable that many ISA members will be interested in attending this conference, the *JOURNAL* will attempt to publish a condensed schedule of the meeting in next month's (March) issue.

Official News

CONSTITUTIONAL AMENDMENTS APPROVED

In the leading editorial in the December issue of the *JOURNAL*, entitled "YOUR Board of Directors," one of the proposed changes in the I.S.A. Constitution was explained, together with the personal hope of the Editor that it would be approved when brought to a vote by the members.

The ballots for this and two other proposed changes in the Constitution were distributed to the members after the editorial was sent to the publisher and before the December *JOURNAL* made its appearance.

It appears, however, that the editorial appeal was unnecessary. According to the tabulation of the ballots returned, as reported by the Executive Committee, all three amendments were approved by an average majority ratio of approximately 20 to 1.

To review this amendments, which go into effect immediately, the changes are as follows:

1. Article VIII, Paragraph (4) is changed to read "No regularly elected officer, except the Treasurer and the Executive Secretary, shall succeed himself in the same office."

2. Article IX is changed thus: Paragraph (1) to read "Each Section shall elect one member to the Board of Directors and shall specify his term of office." Paragraph (4) is eliminated, and Paragraph (5) becomes (4).

3. Article VIII, Paragraph (2) will now read: "This election shall be held at the annual meeting of the Board of Directors."

New copies of the Constitution and Bylaws soon to be printed, will include these changes.

TO ALL SECTION SECRETARIES

The following changes and additions should be made in the list of Section Secretaries, Directors and *JOURNAL* Correspondents published in the December, 1947 issue of the *JOURNAL*.

CENTRAL INDIANA: Director—W. H. Sisson, Brown Instrument Company, 1007 North Meridian St., Indianapolis 4, Ind.

CHARLESTON: New Secretary — W. E. Warner.

KANSAS CITY: New Secretary—W. J. Blackburn, Brown Instrument Company, 1621 East 31st St., Kansas City, Mo.

RICHLAND (New Section as of Jan. 1, 1948): Secretary—B. E. Woodward, Instrument Department (Standards Section), General Electric Company, Hanford Works, Richland, Washington; *JOURNAL* Correspondent—John Flickinger, 1005 Robertdeau, Richland, Wash

SARNIA: Director—W. J. McKay, 261 North Brock St., Sarnia, Ontario, Canada.

GENERAL COORDINATING COMMITTEE REPORTS PROGRESS

The recently formed General Coordinating Committee of the Third National Instrument Conference and Exhibit has submitted its first report on the progress of the plans for the Philadelphia meeting next September 13-17. This meeting, directed by Ed Grace of the Philadelphia Section, recently appointed Chairman of the ISA National Meetings Committee, was attended by representatives of the ISA, the American Institute of Physics, the Meetings and Divisions Committee of ASME, the Executive Committee of the IIRD of ASME, the Philadelphia Section of ASME, and the Joint Subcommittee on Electronic Instruments of the AIEE, all of which groups are cooperating in the Conference.

According to Secretary Rimbach, the ISA will furnish each cooperating society with the necessary meeting rooms and equipment (projection equipment, etc., outlets, gas, air, etc.) a booth in the exhibit hall, aid in arranging for hotel room reservations, badges and invitations imprinted with the name of the society, registration service, and speakers' breakfasts. Each society has appointed a member on the General Coordinating Committee, and will appoint a member on the Press Relations Committee.

These points, as well as the subject matter of the various technical papers to be

I.S.A. CALENDAR OF EVENTS

Section	Date of Next Meeting	Type	Place	Speaker	Subject
Aruba*					
Baltimore	3/12/48	M8X	Baltimore Engineers Club, 6 W. Fayette St.	Dr. T. L. Smith, Chief Engr., Supersonic Wind Tunnel, Aberdeen Proving Grounds	
California*					
Central Indiana	3/2/48	MX	902 N. Meridian St., Indianapolis	Discussion Program	Control & Measurement Films, General Motors Corp.
Charleston*					
Chicago	3/8/48	MX	Peoples Gas Auditorium	Five Local Authorities	Panel Session on Instrument Maintenance
Cincinnati*					
Cleveland	2/25/48	DX8	Cleveland Engr. Society	V. V. Tivy, Foxboro Co.	"Instrument Applications in the Process Industries."
Cumberland*					
Detroit	3/16/48	M8	Rackham Bldg.	Robert C. Scott	"Some Applications of the Electroflux"
Eastern New York*					
Gulf Coast*					
Kansas City	2/24/48	D6X	Crossroads Cafe	Oliver Boutros, Boutros Inst. Lab.	"High Speed Photographic Exposure."
Louisville*					
New Jersey	3/2/48	D68	Essex House Newark	Clifford Ives	"Basic Considerations in Design of Modern Control Valves."
New Orleans*					
New York*					
Niagara Frontier*					
Northern Indiana*					
Oak Ridge*					
Ontario*					
Philadelphia*					
Pittsburgh*					
Presque Isle*					
Richland*					
St. Louis	3/3/48	DX8	Engineers Club	R. Pond, R. Brostedt, Taylor Inst. Co.	"Demonstration of Automatic Control Principles" Dinner, Camille Tea Room
Sarnia*					
South Bend*					
South Texas*					
Southern Michigan	3/10/48			Dr. H. C. Leedy, Armour Research	"Sound and Vibration Measurements"
Tennessee*					
Tulsa*					
Twin Cities*					
Washington	2/16/48	DX8	Pepco Auditorium	Dr. F. A. Firestone, Sperry Products	"The Supersonic Reflectoscope."
Wayne County*					

LEGEND: Meeting only, no dinner—M7, MX or M8 (7 pm, 7:30 pm or 8 pm respectively) Dinner meeting—first symbol D; second symbol time of dinner (6 for 6 pm, X for 6:30 pm, 7 for 7 pm); third symbol time of meeting (7 for 7 pm, X for 7:30 pm, 8 for 8 pm).

*No report as of Feb. 11.

presented by each society, were discussed at the first meeting of the General Coordinating Committee, and work assigned (in some cases it is already under way) to the other committees and subcommittees. Preliminary program information will be available by April or May, according to Chairman Grace, and complete details by the first of July.

The *JOURNAL* will report the progress of the various committees as rapidly as such information becomes available.

Education Committee Meeting

Dr. E. D. Wilson, Chairman of the Education Committee has called a meeting of the Chairmen of the Sub-Committees of the Education Committee. The meeting will be held in the Chemistry Department at the Worcester Polytechnic Institute on March 12th at 10 a. m. All ISA members interested in education are welcome.

Section News

ARUBA

Our 16th regular meeting was held on December 4th at the Engineers Club building This being the first business meeting held since the election of new officers, President Jim Lopez formally thanked the retiring committee chairmen of the permanent committees and appointed the new chairmen for the coming year.

The visit of Mr. Tuininga, Chief Instrument Engineer for the Dutch Shell C.P.I.M. in Curacao, was discussed, followed by a discussion of the new By-laws of the Section. The new By-laws were proposed in an effort to bring the organizational structure of the Section more in line with that of the National Society. This discussion took up most of the evening, and the matter was referred back to the special By-laws committee for further study and revision before being put to a general vote.

During the usual delicious refreshments, further discussion arose over the forthcoming Electronics course and proposed ways of cutting down the amount of time spent on business in our regular meetings.

The 17th regular meeting of the Aruba Section was held on January 6th, also at the Engineers Club building. Following reports by the various committee chairmen, the proposed Electronics course was discussed further ,and it was agreed to get it under way immediately with "The Elements of Radio" by Marcus, Marcus and Horton as a text to find out what level of technical knowledge our study should be based upon.

A new regular feature was introduced under the title "Current Events in Instrumentation." Each meeting will henceforth bring us one or more short talks by members covering newly installed pieces of equipment in the refinery or in the colony. The discussions for the evening were "The Electrocardiagraph" by George Eckelson and "The TELEFOUL" bowling alley automatic foul judging equipment by Bob MacMillan.

The membership expressed the opinion that Chairman MacNutt of the Program Committee had introduced a worthwhile and interesting feature.—L. McGrew, *Corr.*

CUMBERLAND

The Cumberland Section held its regular monthly dinner-meeting on Tuesday, December 16th, at the Algonquin Hotel with President Harry Stern as toastmaster.

The speaker of the evening was Mr. R. J. S. Pigott, Chief Engineer of the Gulf Research and Development Company of Pittsburgh. Mr. Pigott's talk was entitled "Buy on Performance and Depend on Brands." It dealt largely with lubricant and gasoline testing methods and instrumentation, and included quite a discussion on automobile engine performance. The lecture was well illustrated with slides and proved very interesting to all present.

—G. William Harrison, *Corr.*

DETROIT

The December meeting featured a lecture and demonstration by Mr. J. A. Good of the Diamond Power Specialties Company of their industrial television equipment. It proved to be a decidedly interesting topic, as shown by the number of questions asked, and Mr. Good's description was clear to the uninitiated as well as useful to those who have had experience in TV.

The principal uses to which the equipment is being put at present are ones in which it is important to show process information in a place remote from the source—for reasons of safety, convenience or economy. Typical examples cited were (1) control of atomic energy and other processes which are too "hot" to approach

(*Continued on Page* 182)

Moisture Measurement With An Electronic Dew Point Indicator*

By VERNER E. SUOMI
(Director, Department of Meteorology, University of Chicago, Chicago, Ill.)

THE need for an instrument that can accurately and conveniently measure the moisture content of air samples at low temperatures has long been recognized. This need has become particularly pressing during recent years because of the enormous increase of aircraft activity in the stratosphere. This paper describes an instrument that can accurately and rapidly measure the moisture content of air samples over a wide range of temperatures. Although it was developed primarily for meteorological uses, it has many interesting possible applications in industry and agriculture.

Introduction

The most common expression for the moisture content of the atmosphere is relative humidity. Relative humidity is defined as the saturation ratio expressed in percent—

$$100 \times \frac{e}{e_s} = \text{Relative Humidity} \quad (1)$$

where e is the partial pressure of the water vapor in the air and e_s is the saturation vapor pressure corresponding to ambient temperature.

The relation between saturation vapor pressure and temperature can be expressed very nearly by

$$\log e_s = \frac{M}{T} + C \quad (2)$$

where M and C are constants.

The saturation vapor pressure in (1) and (2) is defined by the equilibrium condition between a flat surface of pure liquid or solid and the vapor above. That is to say, as many molecules leave the surface as return to it in unit time. Since it is possible for water to exist below the freezing point either as ice or as supercooled liquid, it is necessary to specify whether the saturation vapor pressures for water below 0°C are measured over ice or water. Tabulations of saturation vapor pressures are given, for example, in the Smithsonian Meteorological Tables[1].

According to Dalton's Law, the total pressure of a gas mixture is equal to the partial pressures e_i of the individual gases. Unless the individual gases enter into chemical combinations, the partial pressure of one is independent of the presence of the others. The partial pressure of water vapor in the atmosphere is therefore a measure of the quantity of vapor contained in a given volume. It may be noted that the relative humidity alone does not specify the water vapor content of an air sample uniquely.

The temperature for which the ambient vapor pressure e corresponds to saturation is called the *dewpoint* temperature. Thus, if an air sample is cooled to its dew point it will become saturated, and if cooled below its dew point it will become supersaturated unless sufficient condensation nuclei are present to permit condensation. The condensation products do not form a flat surface, but appear as droplets or crystals. Since saturation vapor pressures over flat and curved surfaces are slightly different the actual dew point does not have exactly the same value as the dew point defined above. The difference involved is small and is ignored in most cases.

The Author

Mr. Suomi received his B.E. degree in 1938 from Winona State Teachers College. He served as science teacher in various high schools during the next few years, and in 1942 completed a professional course in meteorology at the University of Chicago. Because of the then intensive wartime meteorology training program, Mr. Suomi was retained as a staff member by the University of Chicago to participate in the expanded program. In 1943 a Laboratory of Experimental Meteorology was organized at the University, conducting research in methods of probing the atmosphere. A large portion of this research was concerned with moisture measurement. Mr. Suomi was made Director of this laboratory in 1946.

Other measures of atmospheric moisture content are:

Absolute Humidity: The density of the water vapor.

Specific Humidity: The ratio of the mass of water vapor to the total mass in a given volume of moist air.

Mixing ratio: The ratio of the mass of water vapor to the mass of air in a given volume of moist air.

Precipitable Water: The depth of liquid water that would be obtained if all the water vapor in a column of uniform cross section were precipitated.

Equation (2) shows that for temperatures ordinarily experienced in the atmosphere, the variation of water vapor content can be exceedingly great. Thus for a temperature range of −83° to +30°C the moisture variation for saturated conditions has a range covering five decades of the logarithmic scale. For other than saturated conditions this range is even greater.

Methods of Humidity Measurement

Middleton[2] has listed the following six distinct methods of measuring humidity:

(1) Thermodynamic method (psychrometer)
(2) Methods using hygroscopic substances (hair hygrometer, etc.)
(3) Condensation method (the dew point hygrometer)
(4) Absorption methods
  (a) Chemical (gravimetric, volumetric)
  (b) Electrical (change in resistance, dielectric constant)
(5) Diffusion methods (vapor pressure measurement)
(6) Optical methods (spectroscopic hygrometer)

With the exception of the dew-point method (3) each of these methods has as a basis for humidity indication a scale reading that is roughly linear with vapor pressure.

In general,

$$\text{moisture indication} = K\,e \quad (3)$$

where K is a proportionality factor that depends on the instrument and may vary slightly with temperature. On the other hand the dewpoint temperature can be expressed by rearranging equation (2)

$$T_{\text{dew point}} = \frac{M}{\log e_p - C} \quad (4)$$

The dewpoint method thus has a fundamental advantage over other methods of hygrometry in that its percentage accuracy is very nearly constant for the entire temperature range. In the other methods of hygrometry listed it is meaningless to say that an instrument is accurate to 1% relative humidity unless the temperature range is specified, or unless there is some sensitivity changing device built into the instrument. The enormous change of sensitivity necessary can be illustrated with the spectroscopic hygrometer.

The latter consists of a grating spectroscope separated by a known distance from the projector. The energy received in a portion of the spectrum where water vapor absorption exists is compared with that received in a portion where there is no water vapor absorption. The difference between the received energies is a measure of the water vapor present in the path. The instrument can be made sensitive to small quantities of water vapor by increasing the path length. If the path length for a hypothetical instrument must be 10 cm for a full scale indication at +30°C it must have a path length of 1 kilometer at −83°C to have the same percentage accuracy (see appendix).

Beginning near the freezing point, the accuracy of results obtained with a psychrometer decreases rapidly with

*Presented at the Second Annual Conference of the Instrument Society of America, Stevens Hotel, Chicago, Ill., Sept. 8-12, 1947.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

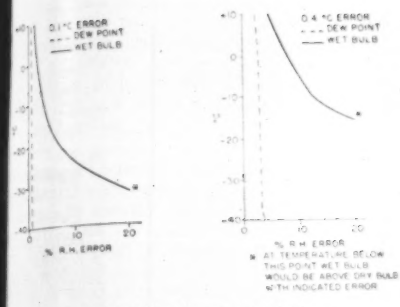


FIGURE 1. CURVES SHOWING ERROR IN COMPUTED R.H. AT TRUE 80% R.H. WHEN INDICATED ERRORS IN OBSERVED DEW POINT AND WET BULB ARE INCLUDED IN R.H. COMPUTATION

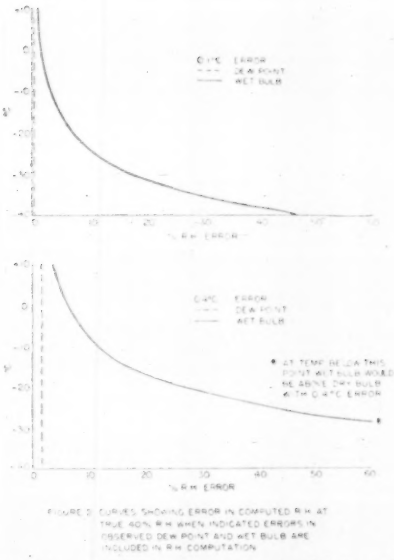


FIGURE 2. CURVES SHOWING ERROR IN COMPUTED R.H. AT TRUE 40% R.H. WHEN INDICATED ERRORS IN OBSERVED DEW POINT AND WET BULB ARE INCLUDED IN R.H. COMPUTATION

lower air temperatures. In addition the difficulty of making psychrometric observations increases. Fig. 1 and 2 show the errors in relative humidity computation resulting from an error in the wet-bulb reading as compared to that in making the same error in reading the dew point. The curves show that a given error in wet-bulb measurement produces a rapidly increasing error in the relative humidity as the dry-bulb temperature is lowered. The same error in the dew point measurement produces: (1) a smaller error in all cases, and (2) an error that is very nearly constant with decreasing dry-bulb temperatures.

Table I shows another advantage of using the dew point instead of the wet bulb for moisture measurements. The fact that the dew point is much less affected by pressure changes, together

TABLE I—Changes in the value of the wet bulb and dew point for 50 millibar pressure changes.

Pressure change	*Temperature*	*WB change*	*DP change*
1000-950	+15°C.	2.0°C.	0.7°C.
1000-950	−5.0°C.	2.8°C.	0.7°C.
500-450	−20°C.	5.8°C.	1.2°C.
500-450	−35°C.	6.3°C.	1.2°C.

with the fact the dew point is conservative for all temperature changes above saturation temperature, gives this method a great advantage over the psychrometric method for measuring the moisture content of air moving at high velocities. A dewpoint hygrometer allows a sample of the air to be brought to the instrument through a tube and its velocity greatly reduced without error due to dynamic and frictional heating. The error caused by the pressure difference between the point of sampling and the instrument will in general be small enough to be ignored for many applications, or could be eliminated by measuring the pressure difference. A psychrometer must be inserted into the gas stream and the effect of dynamic and frictional heating on the indicated wet-bulb temperature together with pressure changes due to the disturbed flow around the wet-bulb wick are extremely complex and almost defy correction.

Other important requirements for an ideal moisture measuring instrument are accuracy and reliability. It is possible for a moisture detecting device to be highly sensitive to moisture changes, but this in no manner assures that it is highly accurate. A reliable instrument is one that indicates accurate moisture values or none at all, i.e., it does not give false information. This is extremely important where the instrument's performance is responsible for the safety of a considerable investment.

The Dew or Frost Point Hygrometer

The original dewpoint hygrometer designed by Regnault[3] or modifications[4] of it are commonly used for dewpoint measurement. With this apparatus the operator slowly lowers the temperature of a highly polished surface until condensation just begins to appear. The temperature of the surface is then considered to be at the dew point. Numerous variations of this apparatus have been built, including some which use photoelectric observations to determine the point at which condensation begins. Dobson and Cwilong[5] were able, with such an apparatus, to measure frost points as low as −79°C reliably.

Attempts to build a continuously recording dewpoint hygrometer have been made. One of the most successful of these is that of Thornthwaite and Owens[6]. Johnstone[7] and Tchang[8] have developed instruments in which the onset of moisture condensation is determined by measuring leakage between two electrodes embedded in the cooled surface.

The development of the present dewpoint hygrometer[9] began with a model similar to that of Thornthwaite and Owen. This instrument consists of a mirror cooled by a refrigeration bath and observed by a photoelectric cell. A resistance wire heater coil was located just below the mirror surface. When the photocell detected moisture on the mirror surface a relay was actuated and current passed through the resistance coil, causing the mirror to heat. After the condensate evaporated the relay circuit opened, allowing the mirror to cool again. This off-on control caused the mirror temperature, which was measured by a thermocouple, to cycle from slightly above to slightly below the dew point. With careful adjustment of the heater current it was possible to decrease the temperature range of the mirror cycle to 1°C.

A control system in which the amplitude of the heater current was controlled by the amount of condensate afforded some improvement but did not produce the reliability and simplicity of operation desired. The principal objections to the instruments using a resistance heating coil were the slow speed of response, tendency to oscillate about the dewpoint whenever a change occurred, and the limited dewpoint range over which they would operate without readjustment. This poor performance was caused by the serious time lag between the time the moisture was detected and the time the mirror temperature changed to evaporate it. As a result, at one time during the cycle the mirror temperature was too cold and excessive condensation occurred. This was followed by an overshoot on the high side of the dewpoint. Because of this inherent difficulty another method of heating the mirror was sought.

Dew Point Hygrometer with Induction Heating

The substitution of radio-frequency induction heating in place of the resistance coil heating completely eliminated the difficulties mentioned in the previous paragraph. The high speed with which the photoelectric cell can control the mirror temperature is a feature of the induction heating system which provides its greatest advantage. Thus, it is possible to change the mirror temperature from 0°C to 100°C in two seconds. Any change in the amount of condensed vapor on the mirror surface is immediately reflected in a changing mirror temperature.

Fig. 3 is a simplified schematic diagram of the electronic dewpoint indicator. It is apparent that the photoelectric observing system must be made invariant to changes in the brilliance of the lamp caused by varying line voltage. Several methods of making the measuring circuit independent of the line voltage are possible. One system[10] (the heavy lines in Fig. 3) uses a separate photoelectric cell and control circuit to maintain the lamp at constant intensity. Another system[11] (the dotted lines in Fig. 3) makes use

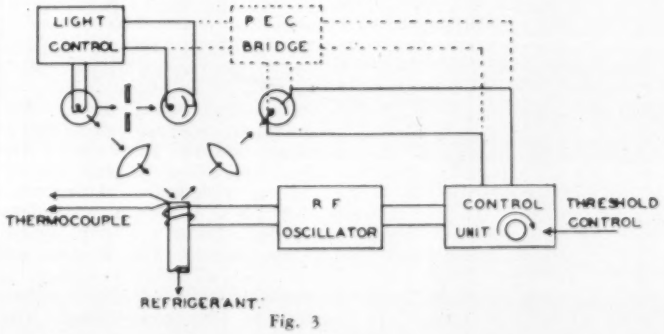


Fig. 3

of the change in light intensity ratio of two light beams. One beam observes the mirror surface while the other beam observes the light bulb directly. Still another method[12] has two identical optical systems. One is used to observe the dewpoint mirror; the other is used to observe a clear mirror. The two signals are fed into a bucking transformer and the difference is used to actuate the control unit.

The operation of the hygrometer can be described as follows: The dewpoint mirror is first heated strongly to remove all condensed moisture from its surface. The threshold control is then adjusted until the oscillator just begins to draw a very small amount of plate current. As soon as the mirror cools to the dew point and a deposit of moisture appears on the mirror surface the control unit increases the power output of the oscillator until the heat lost by conduction to the refrigerant through the mirror body just balances the heat input from the oscillator. At the balance point there is no increase or decrease in the thickness of the moisture deposit. This represents an equilibrium condition between the liquid (or solid) phase and the vapor phase. The temperature of the condensate surface is such that the saturation vapor pressure it exerts is equal to the vapor pressure of the surrounding atmosphere. This temperature has already been defined as the dewpoint temperature. It should be noted that the thickness of the moisture deposit is not important. The only requirement is that the deposit not increase or decrease in thickness. However, it is possible for a temperature gradient to be set up in the moisture deposit, and since the thermocouple is located on the mirror surface and not the liquid surface a very thick deposit of moisture will cause the instrument to indicate a slightly lower dewpoint temperature than is actually the case. This difficulty is removed if the threshold control is adjusted as outlined above.

Accuracy

A manually controlled dewpoint apparatus based on the Regnault principle was used as a check of the accuracy of the dewpoint hygrometer. The mirror for this Regnault apparatus was made of sterling silver with the heater coil far enough away from the surface to prevent any temperature gradients from existing on its surface. Its temperature was measured by a thermocouple carefully spot-welded to its surface. Three groups of observations were made. A series of fifty-two simultaneous checks were made over a dew point range of −0.1°C to −27°C. The difference in the mean Regnault dew point and the mean hygrometer dew point was 0.1°C. The average difference between individual hygrometer and Regnault observations was 0.4°C. In evaluating these data it must be remembered that a single Regnault observation is easily subject to error.

Another series of fourteen observations was made with dew points ranging from −10°C to −35°C. The results were practically the same as the first series: 0.1°C difference in average dew points, 0.44°C average difference between individual readings, and 1.1°C maximum individual difference.

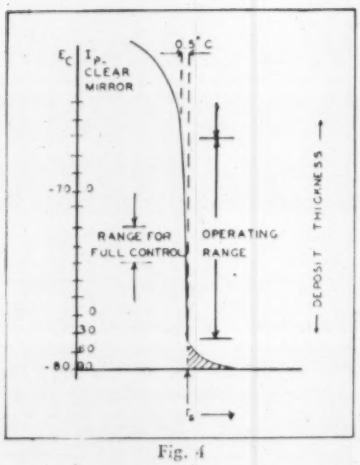


Fig. 4

The final series of tests covered the dewpoint range −5°C to −18°C and consisted of 578 observations. These observations were made over a period of days with five different observers working at various times. Several dewpoint hygrometers were used and various mirrors were placed in the hygrometers. The difference in the average dew points for this data was 0.12°C, about the limit of accuracy of the recorder. The average difference between individual observations was 0.35°C, and the maximum individual difference 2.3°C.

In view of the variety of the observers and dewpoint equipment used in this set of observations, it is felt that these data are representative of the type of results to be expected from the instrument when used in the field or laboratory.

The foregoing results were obtained with the threshold control adjusted to give zero plate current when the mirror was clear. The moisture deposit on the mirror was then easily visible. It was discovered, however, that the instrument could be made to operate with a deposit so thin as to be invisible. When the instrument was balanced with this thin deposit the indicated dew point was several degrees centigrade higher than normal[13]. Fig. 4 shows a plot of indicated dew point against relative frost thickness. Since the control unit output is a function of frost thickness, this, together with plate current and the threshold control voltage are the units plotted on the ordinate. The shaded area is called the "invisible" dewpoint region. Its magnitude depends on the surface condition of the mirror. With an exceptionally well-polished mirror this invisible dew point was measured to be 8°C higher than normal.

The physical processes responsible for this elevated dew point are not fully understood. Probably there is a lowering of the vapor pressure due to the presence of concentrated salt solutions. The latter is partially explained by the fact that the mirror needs to be "activated"[14] in order for the instrument to operate satisfactorily. If a highly polished mirror is made chemically clean and the instrument set for normal operation it was found that the mirror cooled several degrees below the dew point before any condensation occurred. Then a heavy deposit formed very quickly. The control unit turned the oscillator to maximum power and presently all of the moisture on the mirror was evaporated. This sudden deposition and evaporation continued in an oscillatory manner for several minutes, gradually damping out. Presumably, the mirror was collecting condensation nuclei during the period of erratic operation until enough were present to prevent supersaturation.

The steep portion of the curve in Fig. 4 shows the normal operating range of the instrument. The threshold control potentiometer allows the moisture deposit thickness to be adjusted by providing a negative bias voltage in excess of the cutoff value for the control tube. Once this excess bias is overcome, only a very small additional increase in the moisture deposit thickness is necessary to apply full power to the oscillator. Thus it is possible to maintain a chosen constant thickness of deposit. The temperature gradient through the dew or frost increases rapidly if the thickness becomes excessive.

The effect of dirt deposits on the mirror can be shown with the aid of Fig. 4. If the instrument is adjusted to operate with a heavy deposit of moisture on the mirror, an increase in the amount of dirt decreases the frost thickness. A very excessive deposit of dirt will of course cause the instrument to operate in the invisible dewpoint region.

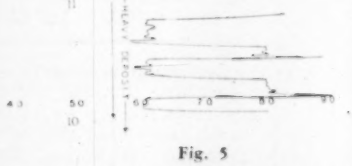


Fig. 5

Performance

Fig. 5 shows a dewpoint record illustrating the speed of response of the instrument. Two air streams, one of high dew point and one of low dew point, were passed over the mirror alternately. The average rate of dewpoint change shown on this record is 6° per second. If the air stream change suddenly a transient condition is caused where the mirror loses or gains an appreciable thickness of moisture deposit. As a result there is overshooting of the true dewpoint values. If, however, the change is gradual, the instrument balances without overshooting.

When the mirror is adjusting itself to a different dewpoint temperature the instrument is not balanced exactly and there is a vapor pressure gradient between the deposit on the mirror and the vapor above. At low temperatures the magnitude of this gradient decreases so if the instrument is adjusting itself to a new dewpoint value it takes a longer time to condense

porate the required amount of moisis necessary for balance. If the mirr is cleared at −50°C it takes about seconds to collect enough moisture normal operation. This of course is ch longer than the time necessary the instrument to balance at a dew point since in normal operan only a very small change in the kness of the moisture deposit is essary for control.

At temperatures below freezing it is sible for the condensate to exist as ercooled liquid or ice crystals. The est temperature at which superled liquid was observed is −35°C. cept in the 0 to −3.0°C range the trument normally operated with ice the mirror. Schaeffer[15] suggests that the mirror is covered with a micropically thin layer of polystyrene the trument will always operate with ercooled water at temperatures ve −35°C and with ice below that nperature, thus eliminating any amguity.

For normal operation it is very easy tell whether the deposit is ice or id by inspection.

The instrument has measured dew nts ranging from +30°C to −67°C. nce the temperature of the mirror n be raised to the boiling point of ter in a few seconds there should be difficulty in measuring dew points gher than +30°C.

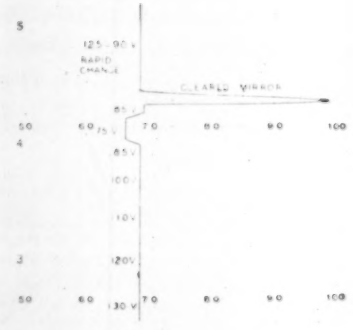


Fig. 6

Fig. 6 shows the response of the inrument to line voltage variations.

Applications

The dewpoint hygrometer is espeally well adapted to the measurement moisture conditions in low-temperare cabinets. Fig. 7 shows the data om a portion of a simulated high-titude flight. The cooling coil section this particular chamber had about e same volume as the test chamber. e two sections were connected with ntilation tunnels that could be opened closed at will. The figure shows that ring steady-state conditions the coilrface temperature is a good approxation of the dew point. It should be ted, however, that this particular amber had a high ratio of coil-surface ea to volume test-chamber volume so at the total frost accumulation on e coils was always thin. The temperure of the air as it comes off the coils uld probably be the best approximaon to the dew point for chambers with w ratios of coil-surface area to chamr volume. In any case, during the alldown or warmup portion of the cle moisture is being condensed or aporated, respectively, and coil tem-

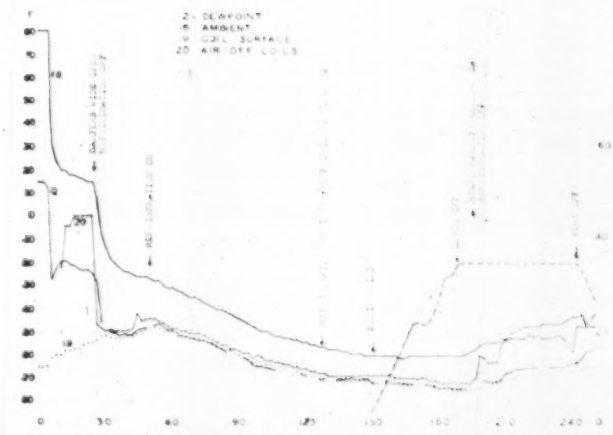
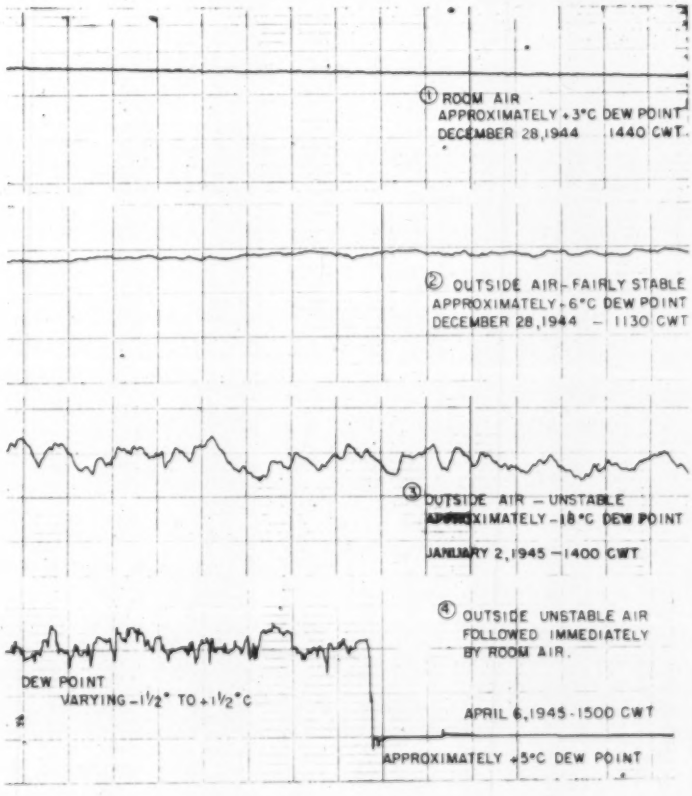


Fig. 7

peratures cannot be used to indicate the moisture content of the system.

Fig. 8 shows free-air dewpoint traces obtained for different weather conditions. The trace with the rapidly varying dewpoint values is of greatest interest. It indicates mixing of a dry air mass with the moisture laden surface layer. This trace was obtained just after the passage of a cold air outbreak. Under these conditions one would expect rapid evaporation because of the turbulent transfer of moisture upward. Although these traces represent observations over land surface the same technique can be applied to smaller scale drying processes. The rate of dehydration can be calculated if the dewpoints of the gas entering and leaving the chamber are known. In addition it is necessary to know the rate of ventilation.

Similarly there is a relation between the moisture content of porous materials and the rate of evaporation. If identical drying atmosphere were passed over dry and moist samples of materials whose moisture content is being determined, the elevation of the dew point would of course be greater over the moist sample. The sampling might be done with a double-walled probe inserted into the material. Dry gas could be passed to the deep end of the probe through the innermost tube. If the outer tube was perforated a transfer of moisture through the holes would occur resulting in an increase in the dew point of the emerging gas. By standardizing the rate of ventilation and the moisture content, the temperature and dewpoint ventilation for specific materials could be ascertained. Once this was established, routine mois-



DEW POINT HYGROMETER
SAMPLE TRACES
TEMPERATURE SCALE APPROXIMATELY 0.5°C PER DIVISION
PAPER SPEED ONE DIVISION PER MINUTE

Fig. 8

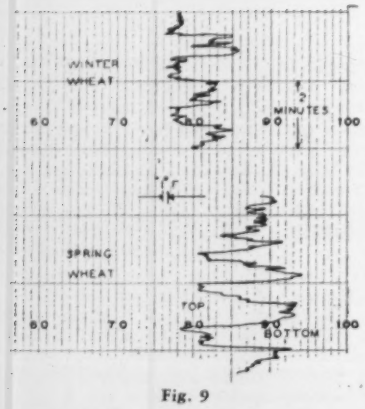


Fig. 9

ture determinations could be made very rapidly.

The instrument is ideal for the study of humidity gradients. In this application a small tubular probe is attached to the inlet of the instrument. Then the atmosphere whose gradient is to be measured is merely explored with the probe. Fig. 9 shows the dewpoint trace obtained by probing the interior of a wheat field. Near the ground the dew point was very high. The value decreased slightly as the probe was raised near the leafy portion of the plants and then dropped sharply near the tops of the wheat stalks. It is interesting to note that the dewpoint values for mature winter wheat were considerably lower than those for young vegetative spring wheat even though the weather conditions were identical. The individual variations of the dew point in each case very closely followed wind gusts.

Samples may be taken from a volume of a gas through a tube 1 to 2 millimeters in diameter. The rate of flow through the instrument can be made low, 50 to 100 cc/min in the case of stable moisture conditions and about 500 cc/min for variable moisture conditions or extremely low temperatures.

ACKNOWLEDGEMENTS

Much of the data used in this report was collected by Mr. D. N. Brissman. The writer is also indebted to Mr. Earl Barrett and to Mr. and Mrs. George Platzman for their aid in the preparation of this manuscript.

APPENDIX

The fundamental equation for spectroscopic hygrometry is of the form[16]

$$A = \sqrt{\frac{P}{P_o}}\sqrt[4]{\frac{T_o}{T}}\,K\sqrt{X} \quad (1)$$

where P_o and T_o are standard pressure and temperature, respectively, and where X is the mass of water vapor in the optical path. K is a factor whose value depends on the spectral region of observation and the amount of water vapor in the path.

A, the fractional absorption is equal to

$$A = \frac{I_o - I}{I_o} \quad (2)$$

X, the precipitable water in the path can be expressed as

$$X = \rho\omega\, L\, a \quad (3)$$

where $\rho\omega$ is the density of the water vapor. L and a are the length and area of the optical path. Expressing X in terms of vapor pressure e

$$X = \frac{e\, m\, L}{R\, T} \quad (4)$$

where m = molecular weight of water and R = universal gas constant.

Substituting in (1)

$$1 - \frac{I}{I_o} = K\sqrt{\frac{P\,L\,M}{P_o\,R}}\sqrt[4]{\frac{T_o}{T^3}}\,e^{\frac{1}{2}} \quad (5)$$

differentiating with respect to e

$$\frac{dI}{de} = -\frac{K\,I_o}{2}\sqrt{\frac{P\,L\,M}{P_o\,R}}\sqrt{\frac{T_o}{T^3}}\,e^{-\frac{1}{2}} \quad (6)$$

thus it would seem to indicate that the sensitivity is higher for low values of e. However, $\frac{dI}{de}$ represents the change in I for a unit change in e. The equation states that the change in I for a change in e from 0 to 1 millimeters is greater than the change in I for a change in e from 20 to 21 millimeters, which is to be expected. Of greater interest is the variation in I for a given percentage variation in e.

The percentage variation in e =

$$\frac{\triangle e}{e} = \triangle(\ln e) \quad (7)$$

then dI =

$$-\frac{K\,I_o}{2}\sqrt{\frac{P\,L\,m}{P_o\,R}}\sqrt[4]{\frac{T_o}{T^3}}\cdot\sqrt{e\,d(\ln e)} \quad (8)$$

and $\triangle I =$

$$-\left(\frac{K\,I_o}{2}\sqrt{\frac{P\,L\,m}{P_o\,R}}\sqrt[4]{\frac{T_o}{T^3}}\right)\sqrt{e\,\triangle(\ln e)} \quad (9)$$

To show the path length necessary for the same percentage accuracy at +30° C and −83° C let I_o be the same in each case.

$$\sqrt{10\text{ cm}}\cdot\sqrt[4]{\frac{273}{(303)^3}}\cdot\sqrt{31.8}$$

$$=\sqrt{L}\sqrt[4]{\frac{273}{(190)^3}}\cdot\sqrt{2.4\times10^{-4}} \quad (10)$$

h = 25.6 kilometers.

It would be impractical to have I_o for a 10 cm path and 25.6 km path equal so the results would be even more unfavorable. The value of K has been shown to decrease with high values of moisture in the path. In any case the 1 kilometer mentioned in the text is a conservative estimate of the required path length.

REFERENCES

1. "Smithsonian Meteorological Tables," 5th rev. ed., Washington 1931, Smithsonian Institution, pp. 166-175.
2. Middleton, W. E. K. "Meteorological Instruments," University of Toronto Press 1943, p. 94.
3. Regnault, V., *Ann. Chim. Phys.*, 15:129, 1845.
4. Kleinschmidt, E. "Handbuch Der Meteorologischen Instrumente," Julius Springer, Berlin 1935.
5. M. B. Dobson with A. W. Bremer and B. M. Cwilong. "Meteorology of the Lower Stratosphere," *Quart. Jour. of Royal Meteorological Society*, Vol. 72, No. 311, p. 144.
6. C. W. Thornthwaite and J. C. Owen, *U. S. Monthly Weather Review*, 68-315, 1940.
7. Henry Fraser Johnstone, *Ill. Engin. Expt. Sta. Circ.*, 20:5-22, 1920.
8. To-Lou Tchang, *Rev. Univ. Mines*, 5:161, 1939.
9. D. N. Brissman, "Preliminary Report on a Dewpoint Hygrometer," Dep't. of Meteorology, University of Chicago, March 1945.
10. *Ibid.*
11. F. A. Friswold, R. D. Lewis, R. C. Wheeler Jr. "An Improved Continuous-Indicating Dewpoint Meter." *NACA Technical Note No. 1215*, Washington, D. C., Feb. 1947.
12. Thomas B. Gibbs & Co., *Technical Bulletin*, Division of Geo. W. Borg Corp., Delavan, Wis.
13. Arthur W. Hixson and G. Edwin White, *Indus. & Engin. Chem., Analyt. Ed.*, 10-235-40, 1938.
14. G. M. B. Dobson with A. W. Bremer and B. M. Cwilong. "Meteorolo... of the Lower Stratosphere," *Quart. Jour. ... Royal Meteorological Society*, Vol. ... No. 311, p. 152.
15. Vincent Schaeffer, General E...tric Co... private communication. 1947.
16. L. W. Foskett and N. B. Foste... "A Spe... troscopic Hygrometer." *The ... the American Meteorologic... Society*, Vol. 24, No. 4, April 1943, p. 1...

Section News

(*Continued from Page 17...*)

safely, (2) water level indicators in boiler rooms where remote-indicating ... equipment cannot be trusted—with television one gets either a true picture of conditions or no picture at all, and (3) remote control of plant gates at night from a central office in which an operator can identify anyone who wishes to enter.

The equipment Mr. Good demonstrated consisted of one camera unit and two receiver units directly connected by cable. Maximum separation between camera and receiver was stated to be 2500 feet. During the demonstration, a boiler water level gauge, a newspaper, a dollar bill, and a small round pressure gauge were televised. The pictures were bright and clear, with excellent contrast, and were clearly visible to members as far distant as 40 feet in the room.—R. A. ROGGENBUCK, *Spec. Corr.*

EASTERN NEW YORK

Over 80 persons attended the Annual Dinner held on December 2. The business portion of the meeting was called to order at 8:15 p. m. It was announced that the students of Siena College were very enthusiastic about forming a student subsection of the Eastern New York Section and President Gildersleeve stated that such a move would receive the full support of the Section.

The annual treasury report was presented and approved, revisions and changes in the Section By-laws were presented and accepted, and the slate for new officers was announced by the nominating committee and elections held. The new officers for the 1948 season are as follows:

President: J. P. Smith, General Electric Company.

Vice-President: W. W. Matlack, Brown Instrument Company.

Recording Secretary: F. H. Brandeau, Behr-Manning Company.

Corresponding Secretary: W. J. Claffie, Jr., Winthrop-Stearns Inc. (re-elected).

Treasurer: J. M. Maitland, The Bristol Company (re-elected).

The Section Charter was then presented to the new President and the business of the evening came to a close.

At this point, members and guests settled down comfortably to hear as guests speaker Mr. Richard Pond of the Taylor Instrument Companies, Rochester, N. Y., who gave a demonstration lecture on "Basic Principles and Mechanisms of Air-Operated Controllers," ably assisted by Mr. Russell Brostedt.

Mr. Pond began his talk with a "fairy tale" about two partners in a chemical batch processing plant who weren't "in the know" on Instrumentation—what they did, what they tried to do and what they should have done. The story ended as all good stories should, and with Mr. Pond receiving well-deserved applause for an excellent presentation.

The first meeting of 1948 was held on Tuesday, January 6th, at Siena College in Loudenville. Mr. J. P. Smith, newly-elected president, conducted the meeting, and immediately after the meeting was called to order, asked Mr. George F. Gardner (Section Director) to present a gold I.S.A. emblem to Mr. Nelson Gildersleeve, retiring president, as a token of appreciation of the Section for the time and effort Mr. Gildersleeve has expended in organizing and guiding the Section through its first and very successful year.

There was little business to be taken care of, and Mr. Smith, acting as Program Chairman, introduced the speaker of the evening—Mr. P. A. Elfers of the Fisher Governor Company—who spoke on "Practical Application of Valves in Automatic Control." —W. J. CLAFFIE, *Corr.*

GULF COAST

The Gulf Coast Section held its annual election of officers on November 20, 1947, with the following results:

Chairman: Ocie L. Weir, 2249 Seventh Avenue, Port Arthur, Texas.

Vice-Chairman: A. V. Weir, 1667 Lucas Drive, Beaumont, Texas.

Sec'y-Treas.: A. E. Bunn, 2237 North Street, Beaumont, Texas.

Program and Publicity Chairman: R. M. Brent, Route 2, Box 98F, Port Arthur, Texas.

Director: R. L. Nichols, 715 Madison Street, Beaumont, Texas.

The above were installed on January 2, 1948. One of the chief aims of the Section is to reach a membership of at least 60 by the end of 1948. —A. E. BUNN, *Sec'y.*

KANSAS CITY

On December 16th, 1947, the Kansas City Section met at the Crossroads Cafe. George Virgin, of Sheffield Steel Company, led off with the first of a series of lectures on Automatic Controls.

Mr. L. M. Swift, Chief Engineer of Engineering Laboratories, Inc., Tulsa, Okla., then gave a splendid talk on unusual instruments used in the exploration drilling and production operations of the petroleum industry.

New officers for the coming year were elected as follows:

President: R. L. Lewis, Economy Equipment Company.

Vice-President: H. C. Van Smith, Standard Oil Company.

Secretary-Treasurer: W. J. Blackburn, Brown Instrument Company.

—W. A. REICHOW, *Corr.*

NEW JERSEY

Despite snow, sleet and icy roads, an audience of over sixty members and guests were gathered for the January 6th meeting to hear Mr. R. M. Johnson, Chief Test Engineer for Ingersoll-Rand Company, outline many of his interesting experiences in the use of instruments and measuring equipment in the testing of large mechanical equipment.

The difference between the instrumentation requirements for such test work and the instrumentation requirements for the manufacturing and process industries was clearly outlined by Mr. Johnson in explaining the uses made of instruments and of the test results obtained with them. The part which testing plays in the manufacture and development of heavy equipment was clearly explained—thus revealing to us an additional important part which instrumentation plays in American industry. It became obvious, during his talk, that the accurate measurement of operating conditions, inputs, outputs and efficiencies has had an important part in the gradual improvement in the types of equipment in use today.

As the result of the meeting and the discussion period, many of us have a much better appreciation of the difficulties involved in applying the instruments and making the measurements to determine output and efficiency of equipment such as large industrial air compressors, steam turbines ranging in size from 20 to 20,000 horsepower, turbo blowers of the type used in the steel and oil industries discharging air in quantities up to 150,000 cfm, steam jet vacuum pumps, and the many other types of equipment manufactured for industry.

Mr. Johnson discussed at some length various experiences with flow and pressure measurement—namely our "old friend" pulsation—and by referring to the ASME test codes outlined the methods used to alleviate and eliminate such problems during the testing of compressors.

—H. F. MOORE, H. M. MCCARTHY.

NIAGARA FRONTIER

(Received too late for January issue)

The Niagara Frontier Section held its monthly meeting on November 24th, 1947, at the New York State Institute of Applied Arts and Sciences. President Clarence Boltz directed a short business meeting which covered reports to the membership by the Program, Membership, Publicity and Constitution Committees.

The speaker of the evening was Paul E. Mohn, Dean of the Engineering School of the University of Buffalo. His topic was "Fluid Mechanics." Dean Mohn presented a discussion of fluid phenomena in pipes and illustrated it by means of movies. He prefaced the talk with an explanation of the background and difficulties incumbent in the hydraulic studies undertaken by him and his associates at the University of Illinois. Water was pumped through glass pipe and carbon tetrachloride and benzine were injected into the stream. Moving pictures were taken continuously and the velocity shown by means of suspended globules, and the resultant Reynolds numbers were studied. Turbulence, streamlined flow, orifice flow phenomena and line blocks were graphically illustrated.

As may well be suspected, a long and active discussion period followed this excellent and instructive presentation. Dean Mohn announced that he intends to develop these studies further at the University of Buffalo.

This Section highly recommends this presentation to all Sections.

Who's Who in the I.S.A.

CLARENCE W. BOLTZ

(Director, Niagara Frontier Section)

Clarence W. Boltz, President and Director of the recently chartered and rapidly developing Niagara Frontier Section, has a highly diversified and interesting background of experience which has led him to his present position as Instrument Engineer for the National Analine Division of Allied Chemical and Dye Corporation in Buffalo.

"Nutzen" Boltz, as he has been aptly dubbed, was born in Buffalo on May 21st, 1905; progressed through the public schools and was graduated from the Seneca Vocational School in 1921, having completed the Practical Electricity curriculum. The next few years involved a range of jobs from motor winding to working for the Van Dyke Baggage Company. A little "mule skinning" activity occurred during this period. He went to work for the Buffalo Body Corporation and Buffalo Pressed Steel Company in 1923 as a designer. This work involved Pierce Arrow bus, truck and custom body designs. A course in Kiln Drying at the New York State College of Forestry provided academic detail to the art of the drying of lumber used for the body frames. He ultimately was made Chief Engineer.

During the year of 1934-37 he worked in Plant Engineering for the Ford Motor Company, Final Engineering Inspection for the Colonial Radio Corporation, and on air conditioning installation for the Pullman Company.

Throughout these years and subsequently, both income and pastime hobby were provided by radio service work.

In March, 1937, he went with National Analine as an electrical draftsman, and after a period of time took over Plant Electrical Engineering.

Instrument application and process control had become, as in many another large plant, a major factor in the position he was administering, and he was soon made Instrument Engineer. The years of practical experience and "gadgeteering" had prepared him well to perform this job with ingenuity and capability.

Clarence is another Instrument man who hobbies as a radio "ham." He built his first receiver in 1919, transmitter (8BZE) in 1921, then W8FNY (funny) and now W2WAC (wacky). "A normal progression for an Instrument Man," says he. When he finishes his new home in the near future, he hopes you other "hams" will QSO him on 20 meters.

His other hobbies have been Boy Scout, Church and Choir work. He sings a mellow baritone, having sung at one time with the Bavarian Men's Choir which toured and won competitive prizes in New York State.

He was married in 1928 and has one son, Charles, age 7½, whom he and his wife, Vera, affectionately call "The Butch." They are expecting by adoption to add to their family in the near future.

E. S. YARLETTS

(Director, Presque Isle Section)

E. S. Yarletts was born in 1912 in the town of Franklin, Pennsylvania, and has remained a Pennsylvanian all his life.

Upon completion of his school work, he joined his father in the contracting business where he remained until 1938. In 1938 he joined The Pennzoil Company to handle electrical and instrument work. By this time he had also completed a number of Penn State Extension Courses in electrical and allied fields.

During the recent war, The Pennzoil Company built and operated both Catalytic Cracking and Hydrofluoric Acid Alkylation Plants. Since no Instrument Department was then existent, Mr. Yarletts helped organize and train a group of men to specialize in this type of work. At present he is head of the Instrument Department, which has grown and become an important factor in the operation of the Pennzoil plants. He is in charge of the selection, installation and maintenance of all the equipment used for measurement and control of the flow of products in these plants.

When the Erie Instrument Society was organized, Mr. Yarletts was one of its first members. Shortly after this group from Erie and Oil City was granted its I.S.A. charter as the Presque Isle Section, Mr. Yarletts was made Director. As such he is a very active member of the group, and has an intense interest in the activities of the Society.

Mr. Yarlett's home is 110 W. Third Street, Oil City, Pennsylvania.

Our December meeting was in the form of a very successful Christmas Party on December 15th at Lindner's Grille. It had been concluded by the Executive Committee and the Program Committee that a Christmas Party, sponsored by the Section, was in order—that it might solidify the new Section by means of the fraternization inherent in a social function.

Millard D. Shriver, Chairman of the Program Committee, acted as Master of Ceremonies. An excellent plate dinner was served, and the rate of beer flow was high.

Russ Milham performed as Dr. I. O. with the very able assistance of several of the local sales engineers. Ten, twenty and thirty-cent payoffs, with a jackpot question and jug of bonded whiskey were contributed as prizes.

One of the high points of the evening was the response to the following Dr. I. Q. tongue-twister: "Measuring meters make meter makers miserable—miserable meter makers make measuring meter." Wes Jessup of Niacet Chemical lost the $1.90 jackpot by responding in disgust, "Miserable meter makers make miserable meters."

Following a song-fest conducted by Clarence Boltz, the party closed in the wee small hours—all in all a most enjoyable and successful meeting.

—RUSSELL MILHAM, *Corr.*

OAK RIDGE

The 21st meeting of the Oak Ridge Section was held at Grove Recreation Hall on January 7, 1948. At the conclusion of the dinner a business meeting was directed by President B. B. Bell. Included in the business meeting was the announcement by the Executive Council of the appointment of Mr. Don Thompson, Monsanto Chemical Co., to the vacant office of Vice-President.

Following the business session, Mr. W. J. Ladniak of the program committee presented a group of films to the complete enjoyment of the entire audience. Various educational films on Electronics, Electrical Circuits, and Vacuum Tubes were among those shown. Also, included in the program as an additional feature in a lighter vein, was a film entitled "Football at West Point," which showed all the inside dope on how Army did it.

The February meeting features former National Vice-President J. B. McMahon of Republic Flow Meters Company, Chicago. We are indeed looking forward to his presence. —J. O. ALEXANDER, *Corr.*

RICHLAND

The Charter for the recently organized Richland Section of I.S.A. was granted effective January 1, 1948. Interest has been high at the first two meetings as evidenced by the fact that one hundred applications for membership have been received to date. Officers elected include: President—E. See Day, Jr.; Vice-President—G. G. Matthews; Secretary—B. E. Woodward; Treasurer—R. W. Lutz.

Mr. H. D. Middel, Instrument Department Superintendent for Hanford Works, General Electric Company, spoke before the second meeting of the Section on December 10th. Speaking on the subject "Instrumentation in Our Future," he first outlined the desirable qualifications of a perfect instrument man. An interesting series of illustrated slides was used to explain conventional instrument applications, and to show some of the special apparatus